THE ATOM

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The Search for a Hole in the Sky at the Top of the World

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THE ATOM

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COVER

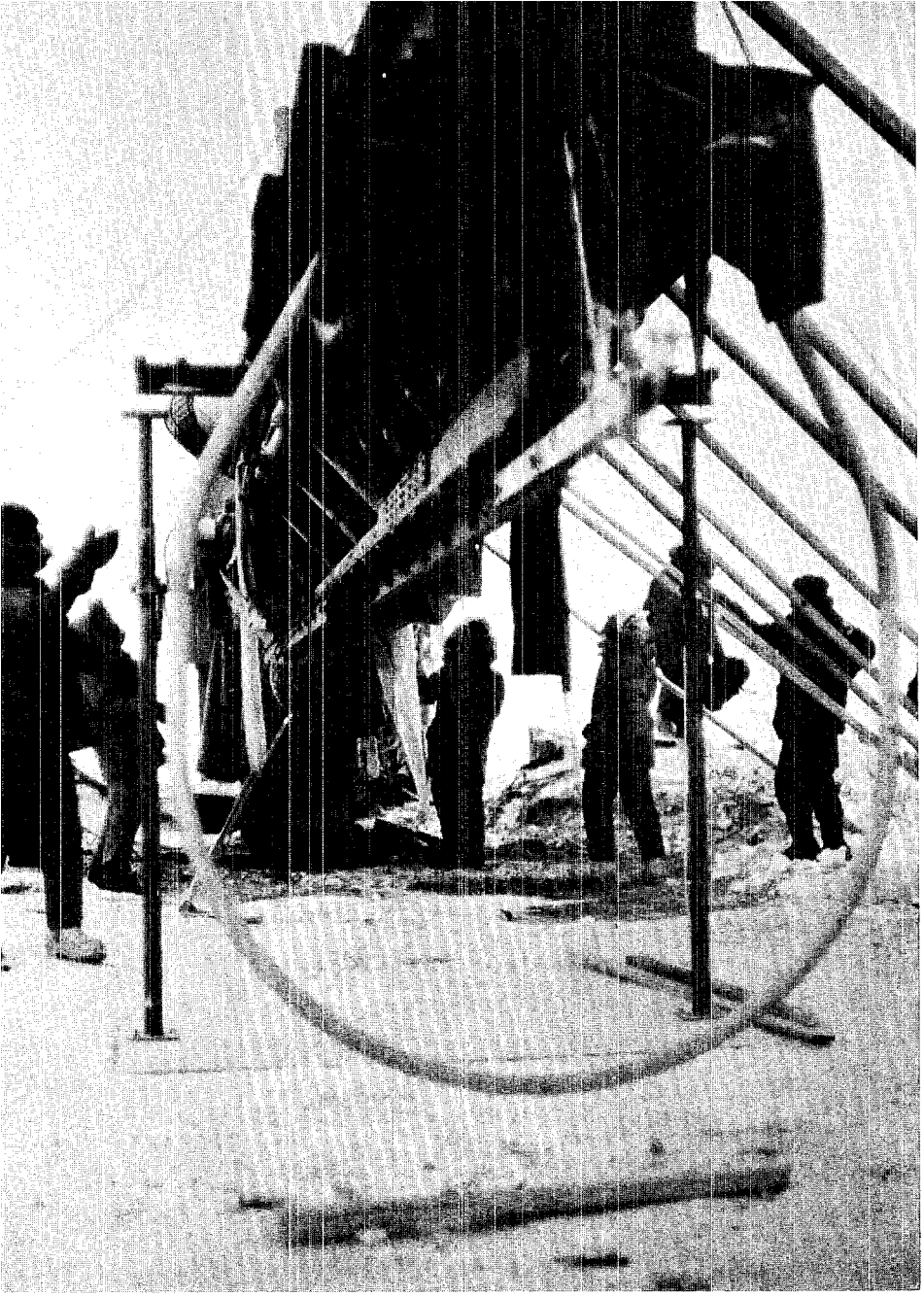
A member of the Operation Tordo field force, face protected against fierce cold and penetrating wind, stands by a microrelay tower at Cape Parry on the shore of the Arctic Ocean. The men involved in the monumental project overcame hardship and numbing fatigue, mishaps and equipment failures, and the intricate problem of locating a wandering magnetic region in the polar sky to bring back a wealth of data on the little-known magnetospheric cleft. The story begins on the opposite page.

ISD-7 cinematographer Rob Gordon, assigned to record events at Cape Parry on movie film, also brought along a still camera in hopes of grabbing a few shots for *The Atom*. So bitter was the cold that ice formed on a heat lamp (above). Once outside, Gordon could not adjust focus, shutter speed, or lens stop: these mechanisms froze in a matter of seconds. Several rolls of film, made brittle by the cold, shattered in the camera.

Outdoor light was abominable, equivalent to that of a murky dawn. Gordon shot at 1/30 second at f/1.8 and pushed Tri-X film development to an exposure index of 2000—drastic measures normally reserved for shooting such scenes as a candlelight service in a darkened church.

That Gordon obtained any usable photos at all is a triumph. That he succeeded in bringing back so many of high pictorial quality is miraculous.

And as *The Atom* went to press, excellent photos taken by Brook Sandford, J-10, at the Resolute Bay optical station came in. Hastily, layouts were revised to accomodate 2 of them, adding a broader dimension to the story.



The Tordo Chronicles

ATTN: R. R. BROWNLEE, J-DO. THE COMMAND POST OF OPERATION TORDO PRESENTS ITS COMPLIMENTS TO THE DIVISION OFFICE OF THE TEST DIVISION AND HAS THE HONOUR TO REFER TO THE DIVISION OFFICE'S TWX OF 2 JAN AND THIS OFFICE'S TWX OF 3 JAN CONCERNING THE STATUS OF OPERATION TORDO. THE TCP (Tordo Command Post) IS GRATEFUL FOR THIS OPPORTUNITY TO PRESENT THE FOLLOWING STATUS REPORTS FOR 4 JAN AND 5 JAN AND LOOKS FORWARD TO CONTINUING COMMUNICATIONS OF THIS NATURE.

With such courtly, tongue-in-cheek salutation did LASL project codirectors Bob Jeffries and Bill Roach, both J-10, and Jim Wells, J-1, operations officer, begin communication on January 5 between the Tordo Command Post at Fort Wainwright, a U.S. Army base near Fairbanks, Alaska, and the J-Division office in Los Alamos on the eve of the historic Operation Tordo first rocket launch.

Operation Tordo was 2 barium plasma probes of the northern magnetospheric cleft conducted by the Los Alamos Scientific Laboratory, the University of Alaska Geophysical Institute, and Sandia Laboratories, Albuquerque, with technical

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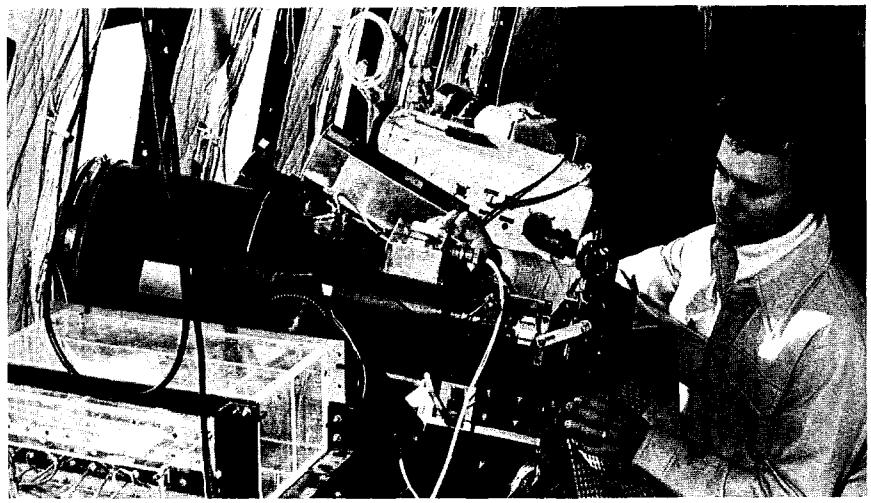
Work at the launch site was impeded by extreme cold and winds. Above left, the launcher is readied. Lower left, a tarpaulin is placed over equipment after high winds blew away the original cover. Right, a launch usually results in some disarray. Repairs are made after the first launch in preparation for the second.



John Wolcott, J-10 and scientific commander aboard Mike 06, examines a battery of standard, image-intensification, and image-orthicon cameras aboard the NC-135. Cameras are mounted behind oversize windows visible in the forward section of the aircraft, below. Photos were taken at Kirtland Air Force Base at briefing and before practice flight on Dec. 12.

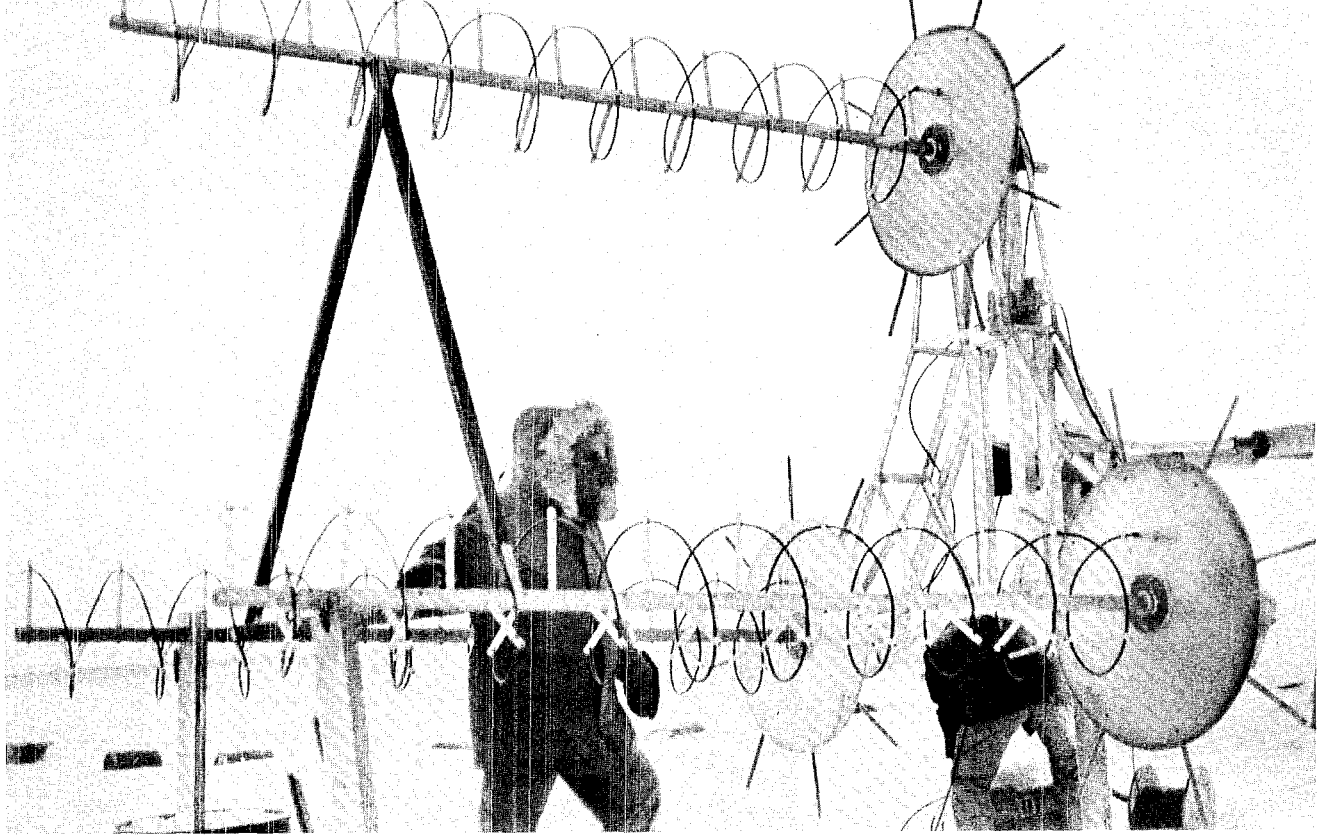
Bill Roach and Bob Jeffries, both J-10, and Jim Wells, J-1, call the shots from the Tordo Command Post at Fort Wainwright, Alaska. An extensive communications network connected the TCP to 4 ground stations, 2 aircraft and their AF bases, and Los Alamos, Albuquerque, and the Nevada Test Site.

services by EG&G, General Dynamics, REECo, Telcom, Inc., and other companies. The Canadian and Danish governments provided essential cooperation and bases, and the U.S. Air Force provided ground facilities and 2 USAF/Atomic Energy Commission NC-135 aircraft with their crews.

Barium plasma injections are a familiar research technique at LASL, which has been a major participant with the University of Alaska in such probes since 1971 and has contributed much to the state of the art. A rocket is launched to a desired altitude (in the case of Operation Tordo, to approximately 500 kilometers), its course is adjusted to one parallel to magnetic lines of force, and a shaped-explosive charge ejects barium at a velocity of about 14 kilometers per second along the trajectory. Solar radiation ionizes the barium, which then glows, and the cloud elongates to a streak that follows magnetic lines of force. The behavior of the barium jet racing across the sky reveals much about the magnetosphere and the effects upon it caused by the solar wind.

More than 70 scientific and technical personnel were deployed at stations in the U.S.A., Canada, and Greenland at the beginning of field operations on December 27, 1974, to conduct 2 probes: Tordo Uno (one) and Tordo Dos (two). A rocket launch site and ionosonde station were established at Cape Parry and an ionosonde station at Sachs Harbor. Both are in Canada's Northwest Territories about 200 kilometers apart on the shores of the Arctic Ocean. Ionosondes are radar-like devices used to locate the layers of the ionosphere. Sudden and substantial changes indicate the boundaries of the cleft.

Optical stations were set up at Resolute Bay in the Northwest Territories, and at Thule, Greenland. The 2 diagnostic aircraft, heavily laden with optical equipment, were stationed at Eielson Air Force Base, Alaska, and Sawyer Air Force Base, Michigan. An international team, representing several European research institutions, in Greenland to



Telemetry antennas are readied for their task of collecting data from soft particle spectrometers and other instruments in the rocket payload. The spectrometers proved valuable in determining the rocket's position in respect to the magnetospheric cleft.

conduct magnetospheric experiments of their own, was prepared to participate in observations.

And what was the object of interest to this expedition? It was the magnetospheric cleft, an invisible funnel extending into space over the polar regions. Closer to the earth's surface, it meanders about the Arctic region where magnetic lines of force curve downward toward the earth's magnetic axis. Plasma from the solar wind comes pouring down the cleft—one of two places in the world where the solar wind may penetrate the earth's magnetic shield (the other being the corresponding cleft near the earth's south magnetic pole). The Arctic cleft may be compared roughly to the vulnerable spot on the tough peel of an orange where the stem used to be.

The cleft is located in the sunlit portion of the auroral oval, that region in the far north which, in darkness, is the home of the famed Northern Lights. Ancient peoples viewed the Northern Lights with awe: Eskimos still consider it a good time to make love.

But modern man views the magnetospheric cleft with less romantic interest. Somewhat superficially studied only since about 4 years ago, understanding it better will fill gaps in our knowledge of the magnetosphere and its interactions with the solar wind. The ever-changing condition of the magnetosphere profoundly affects long-distance radio communication and possibly influences global weather patterns.

Because of the magnetosphere's importance, the International Magnetospheric Study, a two-year effort to study the magnetosphere involving 40 countries, will begin in 1976. Operation Tordo was, in effect, a precursor of this project, and findings from Operation Tordo will be useful in planning this upcoming worldwide program.

If the cleft were a stationary fixture in the earth's magnetic and solar-radiation environment, studying it would be relatively simple. Instead, like a beach ball afloat on a lake, subject to the whims of breezes and currents, its movements are never precisely predictable. The rotation of the earth and resulting position of the magnetic poles, the position of the earth relative to the sun in the solar magnetic field, the intensity and characteristics of the solar wind, and other factors, cause it to wander. Its path may be predicted in a general way, but pinpointing this moving target at the time of the launch—which must be at certain hours on certain dates so that sunlight will ionize the barium at high altitude while ground observation stations are shaded in a moonless earth shadow (so that the glowing barium may be observed)—is tricky business.

Compounding the problem is the necessity of ordering diagnostic aircraft aloft some 2½ to 3½ hours in advance of the launch and timing the launches themselves so that the rockets, in relation to the moving cleft, will be at the right place at the right time to eject barium on a path closely parallel to the magnetic lines of force near the cleft's boundary.

Morris Goebel, Sandia, works on final assembly of the Black Brant rocket, left, and checks barium cone damaged by cold. It was replaced by a new cone. It was later decided that damage would not adversely affect performance and the cone was used in the second launch.

Add to that the rigors of conducting the project in the midst of the harsh Arctic winter and the whole operation becomes immensely more difficult. The January 4 communique from Fort Wainwright, continuing in a less flowery style, gives some idea of the problems Operation Tordo encountered during the hectic days of preparation for the Tordo Uno launch.

THE BLACK BRANT ROCKET SCHEDULED FOR LAUNCH THIS DATE WAS DELAYED 24 HOURS UNTIL 5 JAN DUE TO CONTINUING REPERCUSSIONS FROM THE WIND DAMAGE WHICH OCCURRED AT THE LAUNCH FACILITY ON 31 DEC 1974. HEATER DUCTING TO THE LAUNCHER AREA WAS DAMAGED AS WAS THE PLENUM CHAMBER AT THE HEATER UNIT. REPAIRS ARE UNDER WAY. THE PROSPECT FOR A LAUNCH ON 5 JAN IS CONSIDERED TO BE QUOTE POSSIBLE IF ONE HAS GUARDED FAITH UNQUOTE.

These words fail to picture the scene in all its grim dimensions: Arctic weather so numbing that the Sandia rocket experts were prevented from reaching the launch scene for 12 hours because of a whiteout; when they finally reached the site, they could work but 5 minutes at a time before returning to their heated bus to warm up. It took more than 4 days of concentrated effort to repair damages that occurred when unexpected 60 knot winds blew off the rocket cover.

The severe cold raised havoc with cameras, various other equipment, and one of the NC-135 aircraft itself. Two windows of Mike 06 cracked because of extreme temperatures; replacing them contributed to delays. Mike 06 was the radio call sign for the NC-135 stationed at Eielson AFB in Alaska. John Wolcott, J-16, was assigned to it as its scientific commander.

Dry runs were scheduled and then scrubbed for December 30 and 31 due to weather, rocket, and plane problems. Finally, on January 1, a dry run was held with Mike 06 operative, but with the launch facility at Camp Parry unable to participate. Once aloft, however, Mike 06 developed a malfunction in its instrument system. The Command Post reported:

HAD IT BEEN A LIVE RUN WITH MIKE 06 AND LAUNCH CONDITIONS IN A GO STATE, A ROCKET WOULD HAVE BEEN LAUNCHED WITH HIGH PROBABILITY OF HAVING A SUCCESSFUL EXPERIMENT.

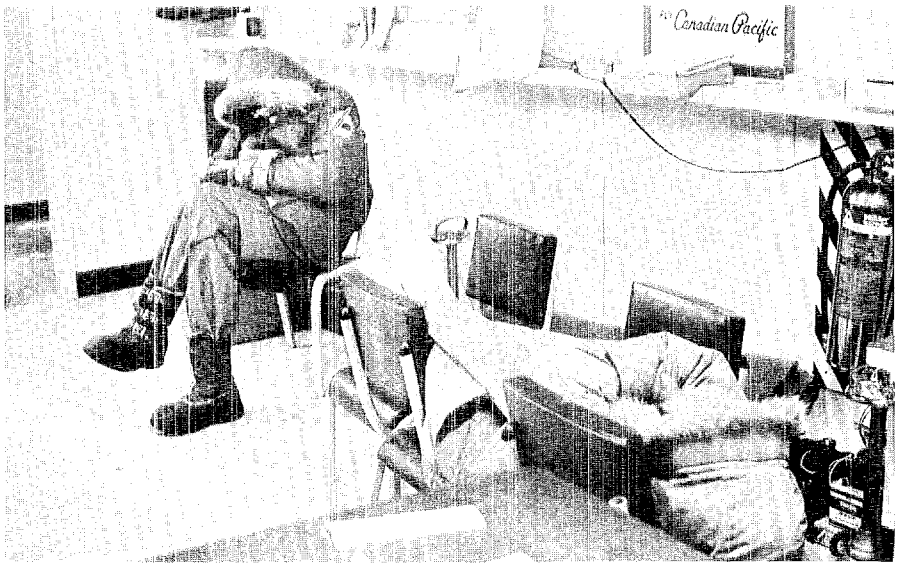
Now began preparations for the live event, but weather hampered repairs, especially at the launch site. A TWX received at LASL on January 4 concluded:

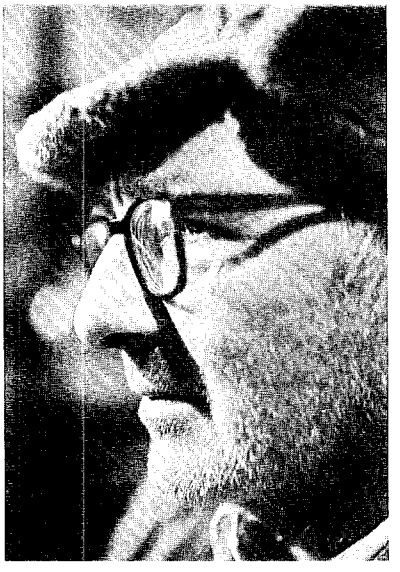
WEATHER CONDITIONS AT CAPE PARRY ON 2 JAN WERE STILL SUFFICIENTLY BAD TO PRECLUDE WORKING AT THE LAUNCH SITE SO THAT A LAUNCH ON 3 JAN WOULD BE IMPOSSIBLE. TEMPERATURE AT PARRY MINUS 30°C, WINDS 25-35 KNOTS, BLOWING SNOW. VERY PROBABLE THAT IONOSONDE PEOPLE WOULD NOT BE ABLE TO GET TO THEIR WORK LOCATION. UNDER THESE CONDITIONS, FIRST POSSIBLE LAUNCH WAS DELAYED FROM 3 JAN TO 4 JAN.

And a subsequent TWX received the same day reported:

CONDITIONS AT CAPE PARRY ARE UNBEARABLE . . . FIRST POSSIBLE LAUNCH WAS THEREFORE MOVED TO 5 JAN WITH A FIRST POSSIBLE EVENT TIME OF 4:33 P.M. (Los Alamos time).

Nevertheless, morale remained sufficiently high for the Command Post to send condolences to their friends in Los Alamos who were having weather problems of their own:





Exhausted by their efforts to repair a rocket damaged by wind and cold, 2 members of the Cape Parry team, left, catnap as best they can. The tension of the countdown is reflected in the face of Hal Fishbine, J-10, right, who was responsible for the soft particle spectrometers aboard the rocket.

TCP AND OTHER DEPLOYED TORDOITES EXTEND SINCERE SYMPATHY TO NEW MEXICANS FOR THE COLD AND SNOWY WEATHER NOW PRESENT IN LAND OF ENCHANTMENT.

On January 5, the launch was scrubbed once again, with the TWX from the TCP reporting a new record low at Fort Wainwright: a minus 50°C.

But on January 6, with weather and equipment at last working in Operation Tordo's favor, the countdown proceeded smoothly and the rocket was launched at 4:49 p.m., Los Alamos time. At this point, communication was by telephone and radio: the exact wording of the report was unrecorded. First indications were encouraging.

Encouragement turned to a great deal more as the data came in and analysis began. The gleefully flowery tone of the opening paragraph gave the tipoff to good news to follow:

THE TORDO STAFF EXTENDS THEIR COLLECTIVE WARM REGARDS AND WISH TO EXPRESS THEIR APPRECIATION FOR THE CONTINUING INTEREST AND MORAL SUPPORT PROVIDED BY YOUR OFFICES. BE ASSURED WE WILL DO OUR UTMOST TO CARRY FORWARD THE BANNER OF SCIENCE IN A MANNER CONSISTENT WITH THE TIME-HONOURED TRADITIONS OF THOSE WHO HAVE PRECEDED US.

And, more explicity:

JUBILATION REIGNS . . . PARTICLE FLUXES SUGGEST EVENT WAS IN POLEWARD EDGE OF CLEFT . . . POSITION OF EVENT ESTIMATED TO BE LESS THAN 1 DEGREE OFF IN BOTH AZIMUTH AND ELEVATION.

The jet that formed after injection behaved differently than predicted. There were some surprises which will be puzzled over for months, during which time data now being analyzed and evaluated may give some answers. Mel Duran, J-10, leader of the Resolute Bay station, reported:

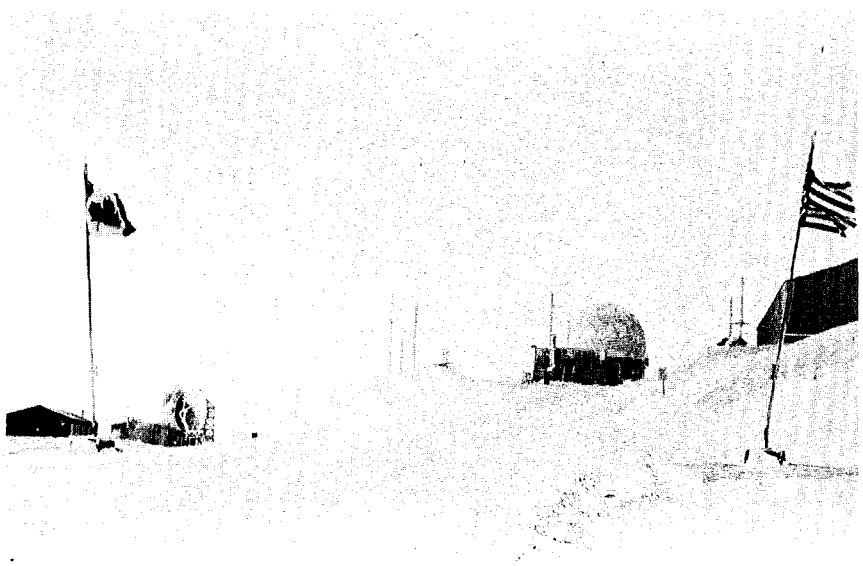
STRIATIONS APPEARED AT 1 MINUTE FOLLOWING EVENT . . .STREAK WAS STRIATED FOR THE REMAINDER OF THE DATA TAKING. INTERESTING OBSERVATION AT 1 MINUTE 54 SECONDS AFTER EVENT: HEAD OF STREAK APPEARED TO BE OVERTAKEN BY FAINTER, HIGH VELOCITY STREAK. WHEN THE 2 STREAKS JOINED, BOTH DECREASED IN INTENSITY.

And Al Huters, Sandia's scientific commander aboard Mike 07 (the other NC-135 based at Sawyer AFB), reported that he believed the streak was brighter than expected. The only major disappointment of the event was the news that the observation station in Thule, Greenland, was unable to observe the barium streak because of heavy snow and overcast.

Even as the field force continued analyzing results of the January 6 launch, preparations began for Tordo Dos, the second probe, targeted hopefully for January 9. Mike 06 continued to experience difficulties—another broken window and a hydraulic system problem. The arrival and departure of LASL personnel gave the authors of TWX communiques opportunities for creative expression:

FATHER CAMPBELL (Bob Campbell, J-Division associate leader) ARRIVED EVENING OF 7 JAN, BLESSED NATIVES, AND DIVLDER (John Hopkins, J-Division leader who had arrived on 3 Jan) DEPARTS THIS AFTERNOON FOR TROPIC LATITUDES. . . .

Weather was now the chief impediment to the second launch, the launch site reporting shear winds at 2,000 feet with a prediction that



Left: Cape Parry—a home away from home. Right: Bulbous pantaloons of Arctic wear distort the otherwise trim figure of Bob Campbell, J-Division associate leader, who flew to Cape Parry for the second launch.

these would persist through January 10. In the meantime, the ground crew of Mike 06 was beginning to believe that Arctic gremlins had infested the aircraft. Repairs had been made on the window and hydraulic system; now an alternator malfunctioned. This caused no delay as repairs were made while waiting for the weather to clear. At the Command Post, the weather was reported as improving:

TEMPERATURES MINUS 35 DEGREES C, WINDS CALM, ICE FOG THINNING. SPRING PLANTING WILL PROCEED IF THIS PLEASANT WEATHER CONTINUES.

Things began improving elsewhere, too, except at Thule, which continued to be bedeviled by snow and overcast. On January 10, the shear winds began to dissipate and winds were diminishing.

As TCP approached the time for it to make its go-no go decision, a growing feeling of optimism pervaded the room.

OUR SPIRITS BUOYED BY TWO BIRDS IN THE AIR (the 2 aircraft) AND TWO EYES ON THE GROUND (the 2 optical observation stations) . . . ALL MAGNETIC INDICATORS SUGGEST A FAVORABLE CLEFT POSITION. FATHER (Campbell) HAS DELAYED HIS DEPARTURE UNTIL 11 JAN IN ORDER TO EXPERIENCE FIRST HAND THE SMELL OF THE GREASE PAINT AND ROAR OF THE CROWD.

The Command Post made its decision: go. Mike 06, still jinxed by instrument and hydraulic problems, had been 37 minutes late in taking off, but had made up the deficit to arrive on station in time. The skies cleared at Thule to allow observations. The launch occurred at 5:25 p.m. Los Alamos time.

TWX communication ceased prior to the launch, but Jeffries and Roach, who returned to LASL the following day, sent a final report to the Atomic Energy Commission:

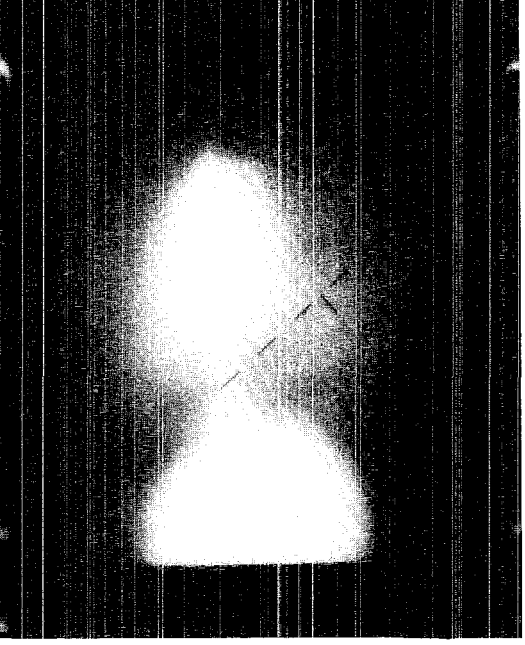
THE TORDO COMMAND POST (TCP), NOW LOCATED THIRTY DEGREES FARTHER SOUTH IN LATITUDE WITH TEMPERATURES SOME SIXTY DEGREES C WARMER, TRANSMITS THIS EIGHTH AND FINAL STATUS REPORT.

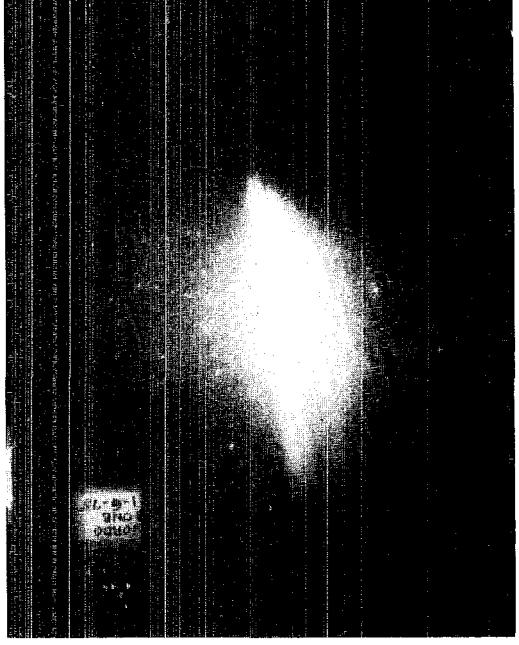
OPERATION TORDO TOTALLY ACHIEVED ITS SCIENTIFIC AND PROGRAMMATIC OBJECTIVES. BOTH ROCKETS FLEW, BOTH PAYLOADS FUNCTIONED FLAWLESSLY, EVERY AIRCRAFT MISSION WAS ON STATION ON TIME AND GO, EVERY CAMERA PULLED WELL-FOCUSED AND WELL-EXPOSED FILM, EVERY TV SCANNED THE SKIES, EVERY RADIO PERFORMED, EVERY HOT LINE TELEPHONE GOT IMMEDIATE RESPONSE, AND BOTH SOUNDERS CONTINUOUSLY PROBED THE IONOSPHERE. ALL IN PROBABLY THE MOST ADVERSE WORKING CONDITIONS POSSIBLE. BARIUM PLASMA WAS INJECTED INTO THE MAGNETOSPHERIC CLEFT ON TWO OCCASIONS, TORDO UNO INTO THE POLEWARD EDGE AND TORDO DOS INTO THE EQUATORWARD SECTOR. PLASMA CONVECTION WAS SIGNIFICANTLY DIFFERENT IN THE TWO EXPERIMENTS. OPTICAL DATA ARE EXTENSIVE AND COMPLETE. NEW TECHNIQUES FOR EVALUATING THE LEVEL OF DISTURBANCE OF THE MAGNETOSPHERE IN REAL TIME WERE DEVELOPED AND UTILIZED. THE SOFT PARTICLE SPECTROMETERS PERFORMED WITHOUT FAULT ON BOTH FLIGHTS.

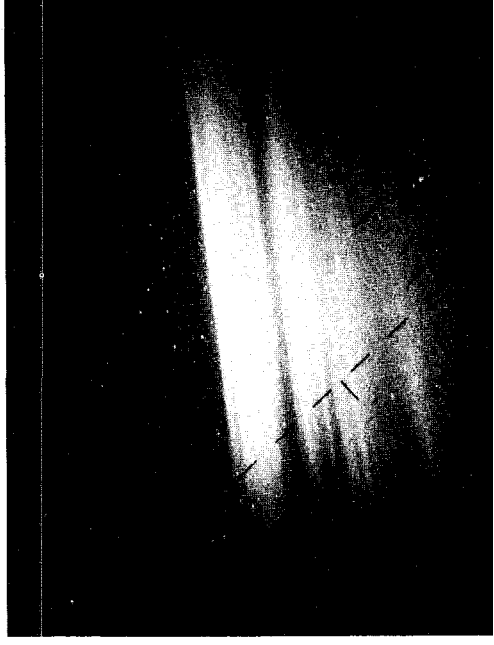
THE TCP IS TRULY IMPRESSED WITH THE RESULTS WHICH REFLECT THE HARD WORK AND GOOD PLANNING OF THE EXPERIMENTERS AND OPERATORS. THE PERFORMANCE OF THE SANDIA ROCKETEERS AT CAPE PARRY WAS SUPERB.

The report concludes with one of the more remarkable understatements recorded in the annals of LASL:

MEN AND MACHINES DO NOT FUNCTION AS WELL UNDER EXTREMELY COLD CONDITIONS AS THEY DO IN MORE TEMPERATE CLIMATES.







Photos selected from hundreds taken of both events from the 2 NC-135 aircraft show barium injected at an altitude of more than 500 kilometers. The left photo, taken 5 seconds after injection, shows the high-velocity jet (top) separating from the relatively stationary residue of barium remaining in the deposition area. The center photo, taken 2 minutes 45 seconds after injection, shows the slightly striated jet following magnetic field lines. The right photo, taken 6 minutes 5 seconds after injection, shows the well defined striations of the barium cloud in the deposition area. Striations, caused by the interaction of the charged particles and the electromagnetic field, appear in both the jet and the cloud in the deposition area.

Casey Stevens, J-10, clears ice and snow from the transparent optical dome, within which cameras are mounted, at the Resolute Bay optical station.

For George Berringer, National Research Council of Canada and range safety officer, John Eckhart, Sandia test director, and Jim Davis, Sandia test conductor, the hours were long, the decisions difficult, the outcome uncertain at the Cape Parry launch site. In the end, both launches were successful.

Mel Duran, J-10, and station scientist at Resolute Bay, reports results following the first launch. Success made it all worthwhile.

PACER

short cut to fusion power?

Of all the exotic alternatives offered as solutions to our energy problems, perhaps one that holds a great deal of promise for relieving the crunch quickly is the use of thermonuclear explosives.

Stop and consider: three decades ago, scientists at the Los Alamos Scientific Laboratory built the first atomic weapons by using the newly discovered technique of splitting the atom to achieve a fission chain reaction. But the research didn't stop there. Now the world has nuclear reactors which, despite some controversy, are producing about 5 per cent of America's electric power. They will probably be producing 20 per cent of that power by the end of this century, and their overall safety record is excellent.

Intrigued by the enormous nuclear furnace, the sun, and its abundant outpouring of energy, LASL scientists perfected the process of fusion and achieved an efficient thermonuclear reaction in a hydrogen bomb. But the research didn't stop there. For 30 years, investigators have worked toward achieving controlled fusion reactions in laboratory-scale machines designed to test the theory of producing enormous amounts of clean, fusion energy via fusion reactors. Such reactors may be producing power in the year 2000, but in controlled thermonuclear research programs such as magnetic confinement and laser-fusion, many problems remain to be solved.

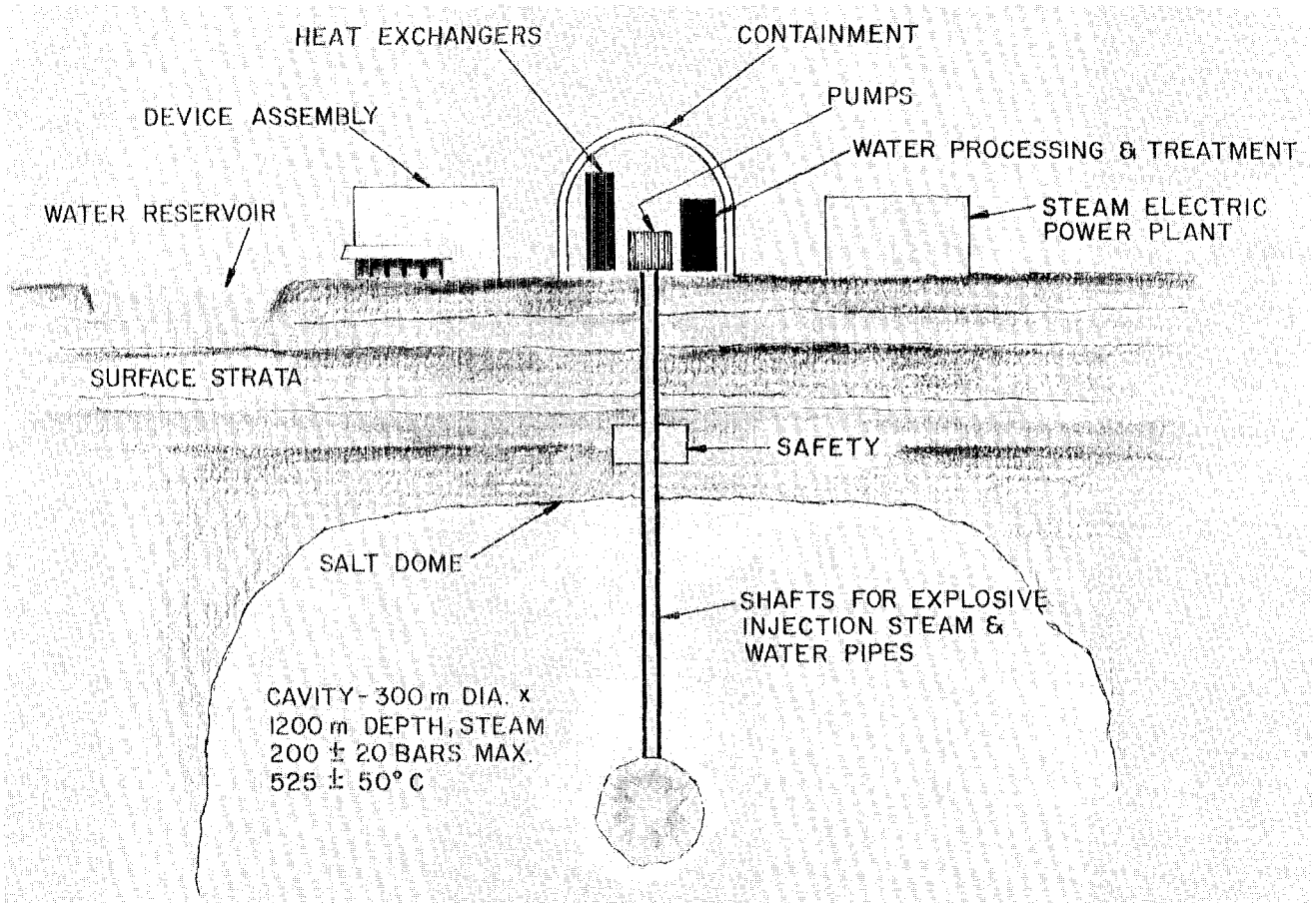
Given these considerations, researchers at LASL, where the first atomic bomb was produced and the first fusion reaction was obtained, are examining the obvious: the use of proven hydrogen weapon technology to provide fusion power and to contain and control it.

The concept has a title. The program is called "Pacer."

Pacer is currently in the initial stage of investigation and is viewed as a power system capable of meeting both short- and long-term energy needs. Its concept is simple, for the energy-source technology is proven. If fusion reactions, which release enormous amounts of energy, can be safely contained in an environmentally acceptable manner, and the energy is extracted in the form of steam using standard power industry techniques, then fusion could probably be harnessed for power within a decade.

Because virtually all of the basic fusion technology required is well known and available now, fusion power conceivably could be supplying a portion of the nation's energy needs long before the turn of the century.

Two similar Pacer systems are being considered at LASL. One system would supply only electrical power, while the other would supply electrical power and simultaneously would breed the materials used as fuel in nuclear fission reactors.



CONCEPT - 2000 MW POWERPLANT

Either way, a Pacer system would be installed underground in a salt dome or large rock cavity. Initially, a small amount of fissionable material, such as uranium-235, would be used as a fission trigger for a thermonuclear device that uses deuterium as its fuel. Eventually it is anticipated that a laser system might be used for ignition.

Deuterium has been described as the ultimate fuel. A heavy isotope of hydrogen, it can be extracted from water easily and cheaply, leaving the water essentially unchanged for other uses. A water flow of less than 30 gallons per second would provide enough deuterium fuel for all of the United States' electrical needs today.

A specific version of a Pacer system might involve repeated 50-kiloton thermonuclear explosions in a salt dome or rock cavity 300 meters in diameter. The intervals between explosions would depend on the power level desired. One 50-kiloton explosion every 10 hours, or 900 explosions a year, could operate a 2000-megawatt-capacity power plant.

A Pacer breeder system, in addition to powering a 2000-megawatt-capacity power plant, could return 5 times the fissionable material used to trigger the thermonuclear explosions. When deuterium burns, and a fusion reaction or thermonuclear burn occurs, a flux of neutrons is produced. These would interact with naturally occurring isotopes, such as uranium-238 and thorium-232, to produce plutonium-239 and uranium-233 that are used as fuel in nuclear fission reactors.

Why use a salt dome cavity for a Pacer system? They are known to be relatively impermeable and stable. There are also quite a lot of them in several areas of the country. Environmentally, they are viewed as the best possible container for repetitive hydrogen explosions and are the easiest in which to prepare a cavity.

What of the economics of such a power system? Indications are that reasonable efficiencies, comparable with conventional power systems, could be expected from a Pacer power system. However, the availability of deuterium and the economic benefits of a nuclear fuel breeder system

would give Pacer a built-in economic advantage.

Technology for transferring the heat of fusion explosions for use as power is available. Either carbon dioxide (CO_2) or, more likely, superheated steam, would be used as the working fluid, removing the heat from the cavity to pass through a heat exchanger system at the surface to power a turbine.

Preliminary estimates with regard to operating costs of a typical Pacer breeder system and a fission reactor are about the same. However, if fission materials can be recovered from the underground system and sold for use in fission reactors, the revenue would amount to the same dollar figure as the cost of operating the system.

In addition to its other advantages, a Pacer system may dismiss the specter of diminishing supplies of the raw materials needed for the nuclear power industry. Experts predict we will run out of these within a century unless a breeder system is used. Pacer proponents say this breeder system could increase the nation's current stockpile of uranium-235, for instance, by a factor of 500, if the material produced can be recovered.

"Pacer is a concept whose time may have come... it could provide part of the solution to our immediate problem of power shortage."

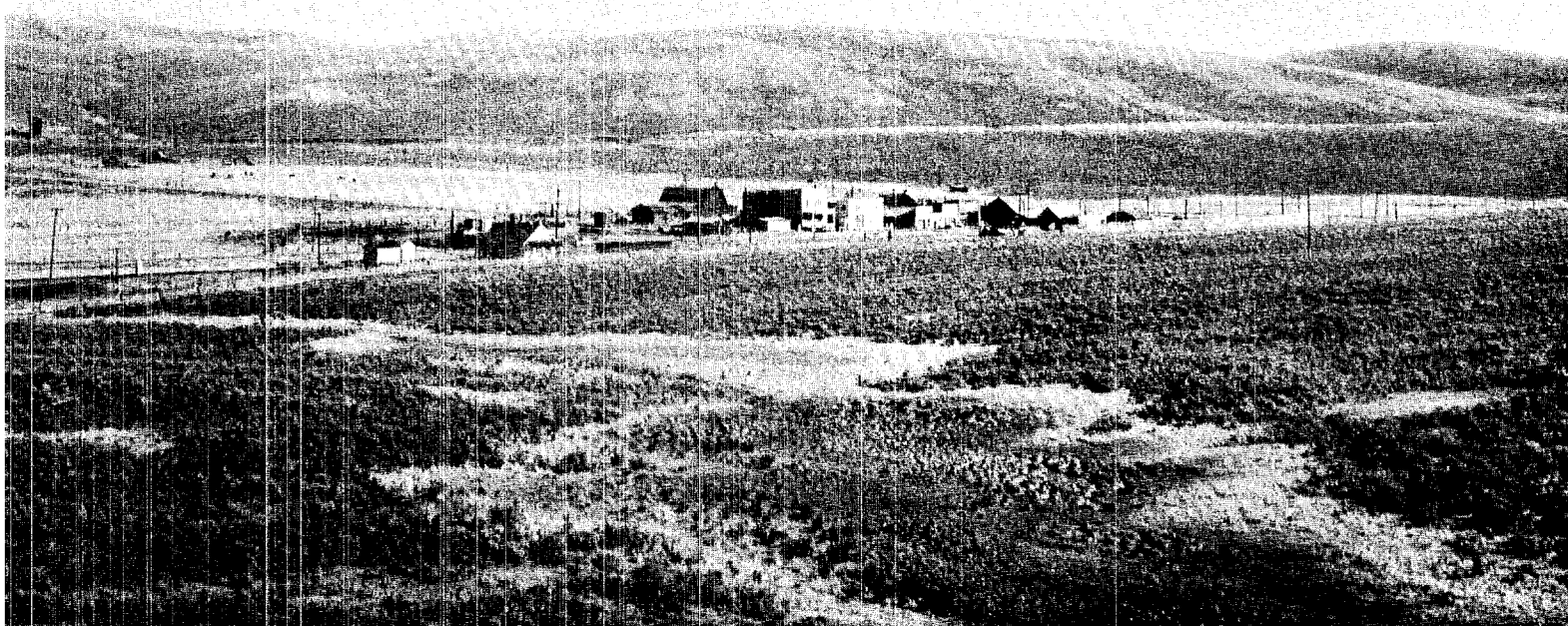
Pacer is a concept whose time may have come It is an intriguing concept. Used in conjunction with a traditional electrical power plant, it could provide part of the solution to our immediate problem of power shortage. Married to a nuclear reactor system, it could extend its productivity. In the long run, its supporters believe, it has no competitor as the principal (and earliest available) source of cheap, clean, and endless amounts of energy.

LASL Director Harold Agnew says of Pacer: "Public acceptance is perhaps the one factor that has held back the concept of using weapons technology to provide relief from our energy crisis. I find it hard to understand why funding for fusion research is essentially inversely proportional to the degree of technical progress that has been made to date. The technology for obtaining fusion in hydrogen bombs exists, but the engineering development to put this energy to work for us has not been funded."

In the wake of our unparalleled energy crisis, the public has become increasingly concerned, sophisticated, and knowledgeable about energy and the alternatives to shrinking and expensive supplies of oil, coal, and gas. Only the future will determine if Pacer becomes a household word attractively synonymous with clean, cheap power.

Assessing a Region's Energy Resources

A New Kind of Challenge for LASL



THE ROCKY MOUNTAIN REGION

The Nation's Energy Breadbasket?

From the first days of the Manhattan Engineer District, challenges have been the Los Alamos Scientific Laboratory's business. Today, LASL faces a new kind of challenge every bit as demanding as those faced in the past: understanding the present and projecting alternate futures in energy development for the 8 states of the Rocky Mountain region.

The 8 states occupy 26 per cent of the area of the contiguous states, on which live but 4 per cent of the country's population. And the region contains over 50 per cent of the nation's coal and oil shale reserves and 95 per cent of its uranium ore.

It is with the utilization of the region's immense energy resources that LASL will be fundamentally concerned: coal, oil shale, natural gas, uranium, and, to a lesser extent, with petroleum, hydroelectric, peat, geothermal, and solar.

But energy resource utilization is inextricably linked with so many other factors that only advanced mathematics and computer technology can cope with the total picture—hence LASL's involvement. Among the factors, each of which contains a huge number of variables and unknowns, are:

—the impact of energy resources development on the local ecosystems, and by extension, to the ecosystems of much larger surrounding areas.

—the costs in water—the one resource with which the Rocky Mountain region is not abundantly endowed. Water in vast amounts is necessary for most processes that extract fuels on a large scale.

—the impact of energy development on people. Energy development projects now on the drawing boards will require totally new cities to be built on now desolate land. Who will pay for schools, roads, services? What will be the environmental consequences and will they be acceptable?

Ultimately, it may be the "people" factors that will prove the most subtle, complex, and unpredictable. What will be the social impacts of rapid urbanization and industrialization on predominantly agricultural and grazing economies?

Will some kind of regional chauvinism emerge as heavily populated, highly industrialized, but energy-poor urban areas seek to tap the resources of the Rocky Mountain states? Or will interregional cooperation and our political processes lead to fairly distributed benefits for all?

Opposing interests are important factors, such as environmentalists versus those who would wish to develop energy, housing, and industry. The demands of the cities—within and without the Rocky Mountain region—may conflict with the interests of agriculture. And always there are the interactions, political and otherwise, among the states themselves from the governors down to the alcaldes of small Spanish towns, with many layers of government agencies in between.

It is not LASL's role to plan development and make decisions. But as the entity that collects and analyzes information, applies scientific expertise in matters such as ecological effects and computer modelling, and provides objective appraisals and recommendations, LASL cannot help but become aware of and, willingly or not, involved in some of these intricacies.

And it is perhaps a healthy thing that LASL does. From its inception, LASL has been orien-

tated toward scientific problems of national concern, and the view has been towards Washington, D.C. Now a new grassroots dimension in LASL's perspectives is being introduced. No longer will place names like Hiawatha, Utah; Reliance, Wyoming; and Axial, Colorado have meaning only to the occasional LASL employee travelling on vacation. These happen to be communities virtually sitting on top of immense natural resources. And in turn, LASL may come to mean something more to the Basque sheepherder in Nevada, the Spanish-speaking farmer in Northern New Mexico, and the Zuni silversmith in Arizona than the remote and guarded place from which so many marvels of the nuclear age have emerged.

A 4-Part Program

The LASL program, titled "Regional Energy Assessment Program," is funded by the Division of Biomedical and Environmental Research (DBER) of the U.S. Energy Research and Development Administration (ERDA) to serve the Rocky Mountain states: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. LASL will be dealing with a number of state executive and planning offices, citizens' groups, industries, and state, regional, and federal agencies.

Because the program doesn't fit neatly into any single division or group, as do most physical research programs, LASL has assembled a task force that cuts across organization-chart lines. Involved are personnel from C-Division (Computer Services), E-Division (Electronics Instrumentation), H-Division (Health Research), Q-Division (Energy), T-Division (Theoretical), TD-Division (Theoretical Design), and the Energy Office.

Project manager Dick Malenfant, Q-DOT, explains the program as consisting of 4 parts:

First, there is the rather formidable task of data acquisition and establishing and managing an adequate data base. U.S. census reports and projections and various state and federal sources will be used for assembling information on population and its distribution by age, skills, ethnic origins, and a number of other characteristics. In acquiring physical data, aerial and satellite photography are among the techniques that will be used. Principally responsible for this work are Russ Kidman, T-2, and Dick Wiley, C-4.

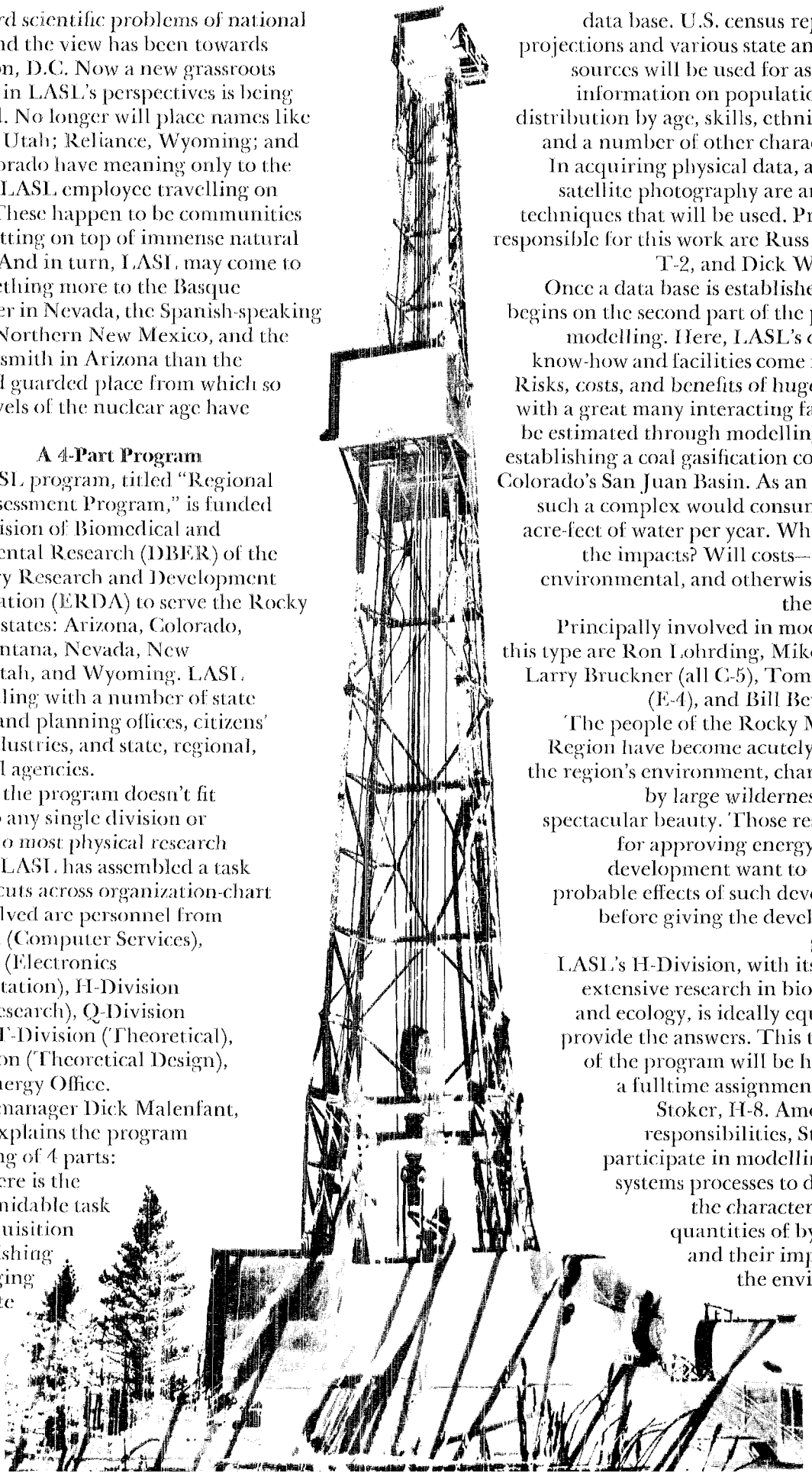
Once a data base is established, action begins on the second part of the program: modelling. Here, LASL's computer know-how and facilities come into play. Risks, costs, and benefits of huge projects with a great many interacting factors can be estimated through modelling, such as establishing a coal gasification complex in Colorado's San Juan Basin. As an example, such a complex would consume 72,000 acre-feet of water per year. What will be the impacts? Will costs—financial, environmental, and otherwise—justify the benefits?

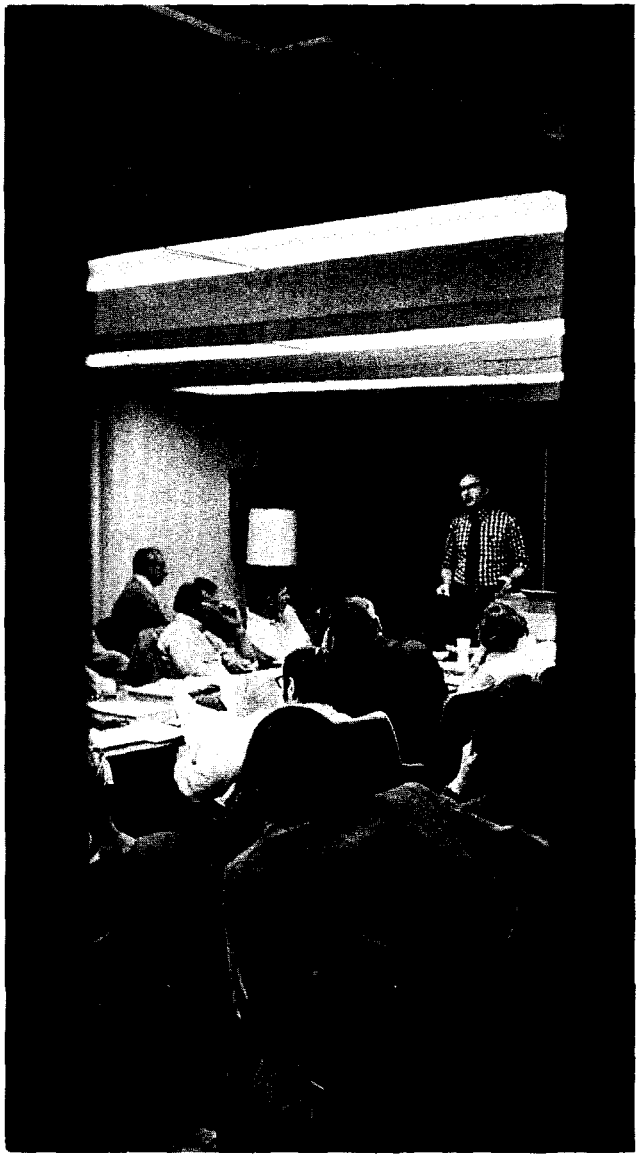
Principally involved in modelling of this type are Ron Lohrding, Mike McKay, Larry Bruckner (all C-5), Tom Springer (E-4), and Bill Beyer (T-7).

The people of the Rocky Mountain Region have become acutely aware of the region's environment, characterized by large wilderness areas of spectacular beauty. Those responsible for approving energy resource development want to know the probable effects of such development before giving the developers the go-ahead.

LASL's H-Division, with its ongoing extensive research in biomedicine and ecology, is ideally equipped to provide the answers. This third part of the program will be handled as a fulltime assignment by Alan Stoker, H-8. Among other responsibilities, Stoker will participate in modelling whole-systems processes to determine the characteristics and quantities of byproducts and their impact upon the environment.

Keeping





Frequent meetings are an essential ingredient of the Rocky Mountain Regional Assessment Program, and have already begun. Here Jim Sawyer, representing Resources for the Future, Inc., research firm, discusses alternative uses of fossil fuels with a group of 30 attending a regional studies workshop on Jan. 9-10 at LASL. Among the participants: Randy Newton, Division of Biomedical and Environmental Research and Development Administration, Allen Kneese, University of New Mexico resource economist, LASL's Dick Taschek, associate director for research, and Don Kerr, assistant for research.

the program coordinated and maintaining liaison with the numerous agencies and offices involved is the fourth part of the program and is one of greater prominence than in the usual LASL research program. Responsible for this are Dick Vogel and Steve Merlan (TD-7) and the staff in Q-DOT.

In addition to working with the various states and agencies of the Rocky Mountain Region, LASL will cooperate with other regions and other laboratories. For instance, Lawrence Livermore Laboratory in California is serving the Pacific Coast Region in a similar capacity, and other laboratories will serve other regions. Some of the means of interregional and interlaboratory cooperation are the creating of common formats for the data base, modelling, and reports and recommendations, and for sharing facilities and know-how as appropriate.

It's all part of the DBER's overall national plan for the orderly development of our nation's resources with acceptable environmental impacts and maximum societal benefits.

Challenges We Will Face

Business Week magazine, in a perceptive article on energy development in the Rocky Mountain Region, speculates that the region will become the U.S.'s energy breadbasket and predicts that energy companies will spend $5 billion by 1980 in Colorado, Wyoming, and New Mexico alone. The preponderant investment will be in coal and coal gasification. The Four Corners area, but 130 miles from Los Alamos and already the site of the nation's largest coal stripmine, is archtypical of the problems presented by energy development on a mammoth scale.

The Western Gasification Company and the El Paso Natural Gas Company are projecting a $115 million community on or near the desolate land of the Navajo Reservation that would accommodate 32,000 persons in 10 years, and would grow to a city larger than Santa Fe by the year 2000. The societal problems appear formidable, especially if the familiar "boom town" syndrome emerges. A policy on water use is desperately needed; recycling slurry-line water or trading New Mexico energy for California's allotment of water from the Colorado River are among the suggested solutions.

In Western Colorado, Colony Development Operation is considering a new community on Battlement Mesa near its proposed oil shale development to accommodate more than half of its own employees. And in Wyoming's Powder

Because oil shale and coal are of particular interest to LASL investigators involved in the Rocky Mountain Regional Energy Assessment Program, Dick Malenfant, Q-DOT, Dick Vogel and Steve Merlan, TD-7, and Ron Lohrding, C-5, pose with samples of the materials on a glass table to emphasize the point. The Rocky Mountain Region contains over 50 per cent of the nation's coal and oil shale reserves. The sample of oil shale, left, contains about a pint of petroleum.

River Basin, 5 companies with coal gasification development plans have completed a study showing the need for a completely new town.

While most current thinking centers on coal, Malenfant suggests the possibility of another type of "energy town" centered on uranium. Considerable economic advantages may result from developing complexes that would process ore from nearby sources, such as from the Ambrosia Lake deposits in northern New Mexico, for fuel for reactors operating on the same site. Among the benefits would be a reduction in safeguards problems and the enhancement of environmental protection. And it may also turn out that LASL's superconducting transmission research would contribute to the feasibility of the scheme, providing the technology for highly efficient transmission of power in large amounts to distant cities.

In these and other "new towns" that are likely to spring up in the Rocky Mountain Region, LASL can provide the essential modelling for others to plan and guide such growth. And in its own backyard may exist an excellent model—the city of Los Alamos itself. Los Alamos as a community did not exist 35 years ago, went through an early "boom town" period, and today is a well ordered city offering a lifestyle which is, in the main, pleasing to its residents.

No single article can cover the ramification of a program whose parameters are the boundaries of 8 states containing a diverse population of 8.8 million with varying problems, needs, and aspirations. Nor can it predict a future that can be altered abruptly and radically by unforeseen political, economic, and scientific events.

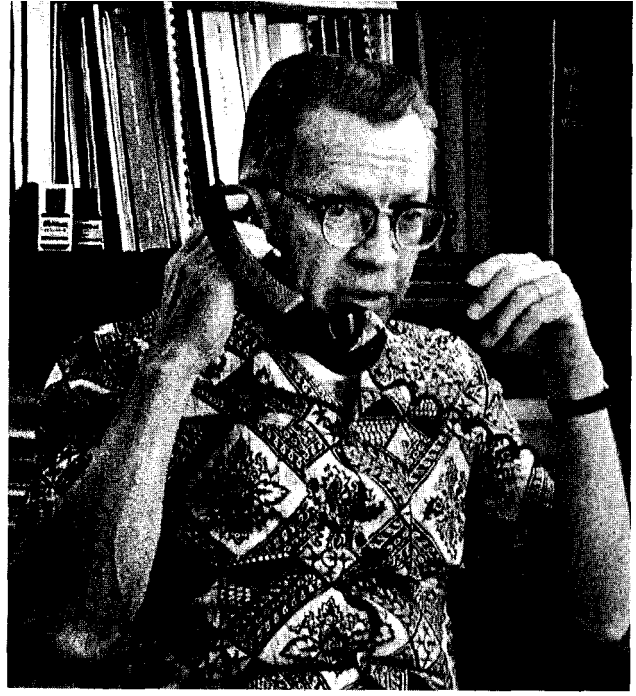
But no group of experts can know all these things, either.

Therein lie the difficulties. But, Malenfant adds with a smile, therein lie the challenge and the excitement, too.

By meeting the challenge with all the tools at LASL's disposal, the Rocky Mountain Region may indeed become the U.S.'s energy breadbasket—but on the Region's terms.

And LASL will have helped.

geothermal update



Mort Smith, Q-22 group leader, puts on a little pressure of his own during frequent calls to the Fenton Hill geothermal site.

PUTTING ON THE PRESSURE

Somewhere almost 2 miles below the surface of the rim of Los Alamos' own "backyard" volcano, the Jemez Caldera, LASL will put on the pressure sometime this month. If all goes well, LASL's geothermal program will have passed another milestone.

Despite some moments of discouragement, and a few of near panic (such as when almost a mile of pipe was dropped down the hole), drilling at LASL's Fenton Hill geothermal site was successfully completed in December when the drilling crew engaged by Q-22 (geothermal energy) found temperatures of almost 200° Celsius at a depth of just under 2 miles. The drilling rig has departed; Q-22 stands ready to attempt the next critical step of its program: fracturing.

To accomplish this, Q-22 will pump water at 2,500 or more pounds per square inch into a 40- to 60-foot section of uncased "raw" rock at the bottom of the hole. Hopefully, this pressure will fracture the surrounding granite in a more or less predictable pattern within a vertical region extending outward to 1,500 feet.

Some 600 feet of steel casing will protect the rock above the fracture point at the bottom of the hole. Then, that casing will be perforated and a second fracturing will be attempted about 300 feet above the first. This second fracturing, Q-22 hopes, will produce cracks connecting to those formed by the first, creating a loop through which water can be circulated.

Based on an earlier test at a lesser depth where 700-foot cracks were successfully produced, Mort Smith, Q-22 group leader, believes that fracturing at the greater depth will be successful and that water pressure alone, if sustained, may be sufficient to keep the cracks open. This would allow adequate circulation to draw off the heat trapped in the underground rock and bring it to the surface.

But if not, several remedies may be applied. One is to add sodium carbonate to the circulating water in an attempt to dissolve some of the silica of which granite is formed. Another is to force gravel of suitable size into the cracks, permanently wedging them open. This operation would entail a penalty in increased flow resistance and its application would be done judiciously.

By whatever means, the net result should be the world's first underground hot, dry geothermal test bed by this spring.

Power Now?

Will this test bed become the "boiler" for a pilot power plant at the surface? Smith says it could, but prefers that it wouldn't.

"Ideally, we will move to another

site in the vicinity and drill 2 more holes for demonstrating heat extraction, keeping our present Fenton Hill site for continuing experiments. There is much to be learned and we need to refine our measurement methods. But if the funding were not available, and if our fracturing is successful, we could probably use the present hole plus another adjacent to it to set up a demonstration system," Smith explains.

Group Q-22 wants to learn the characteristics of the cracks that will be formed—their physical dimensions, the amount of pressure it takes to keep them open—the flow resistance, and the rate at which silica, the basic material of granite, will be dissolved.

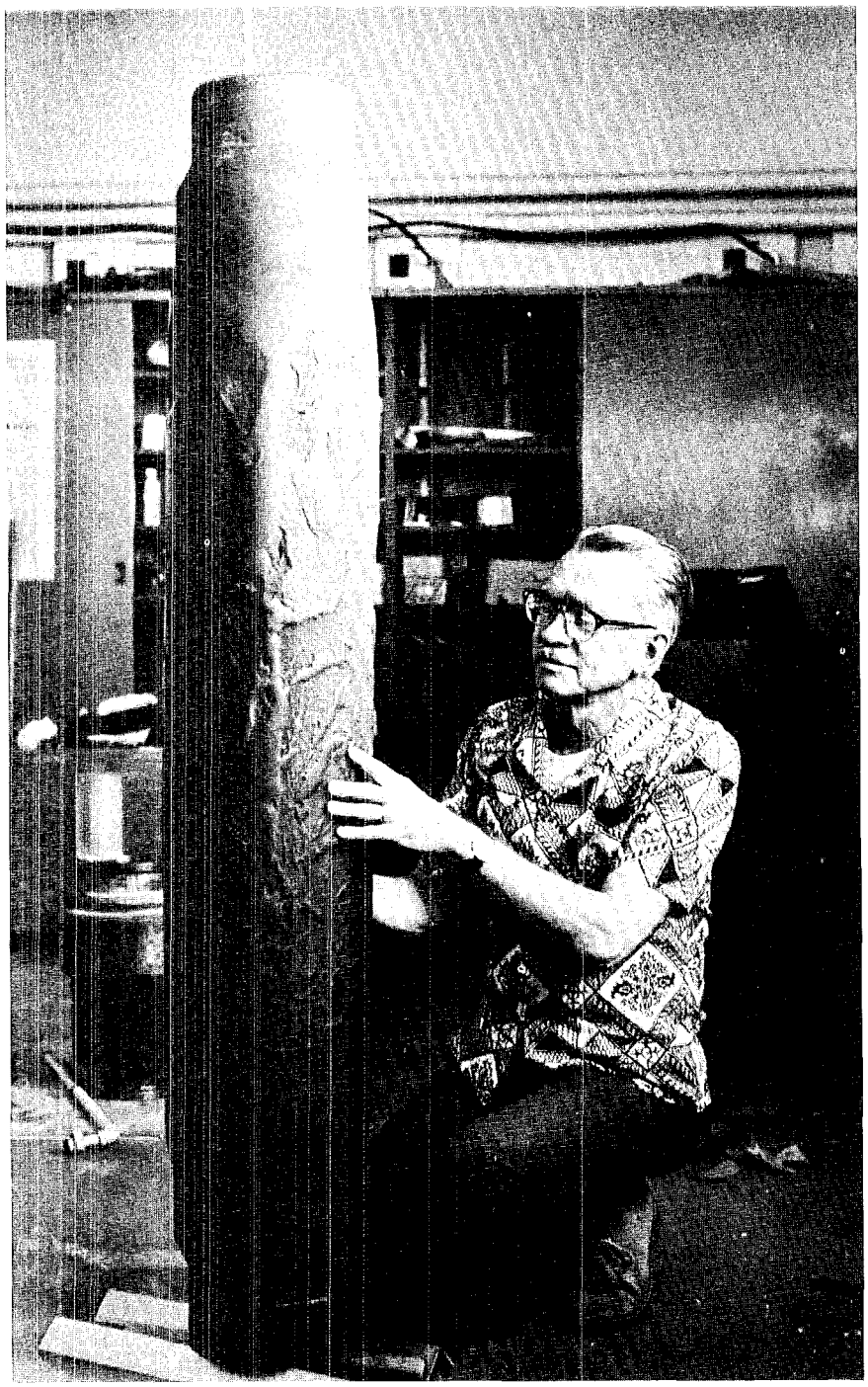
The latter is of particular interest to Q-22, for the presence of minerals in the circulating water would pose scaling and corrosion problems in the operation and maintenance of a future circulating system. So far, the presence of minerals associated with hard water, especially calcium carbonate, is less than expected.

However, the presence of other elements has been greater than anticipated, if not in the water, then in the core samples. Such elements as uranium and copper exist in amounts sufficient to lead to more than idle speculation that someday it may become economically attractive to devise means for removing such mineral resources from deep underground.

Geothermal Spinoff

While the extraction of minerals is, for the present, a remote spinoff possibility, other benefits are not. Out of the present drilling alone may come new and better techniques to serve those who drill holes deep into the earth for any purpose.

For instance, to get an accurate three-dimensional picture of cracks formed in the shaft (or of rock characteristics anywhere along the hole, for that matter), a commercial vendor developed a special packer of hard rubber to withstand the



Newest wrinkle in determining just what is going on almost 2 miles underground is this special packer being examined by Smith. The packer is lowered in the geothermal well. Expanding the cylinder results in an impression of the rock wall of the well on a special hard rubber surface that can withstand heat exceeding that of boiling water.

high temperatures encountered in geothermal drilling. The cylindrical packer is lowered to the desired portion of the hole, pressure of 800 or more pounds per square inch is applied, impressing the rubber on the walls of the hole, and the cylinder is withdrawn with a bas-relief picture of the rock formation.

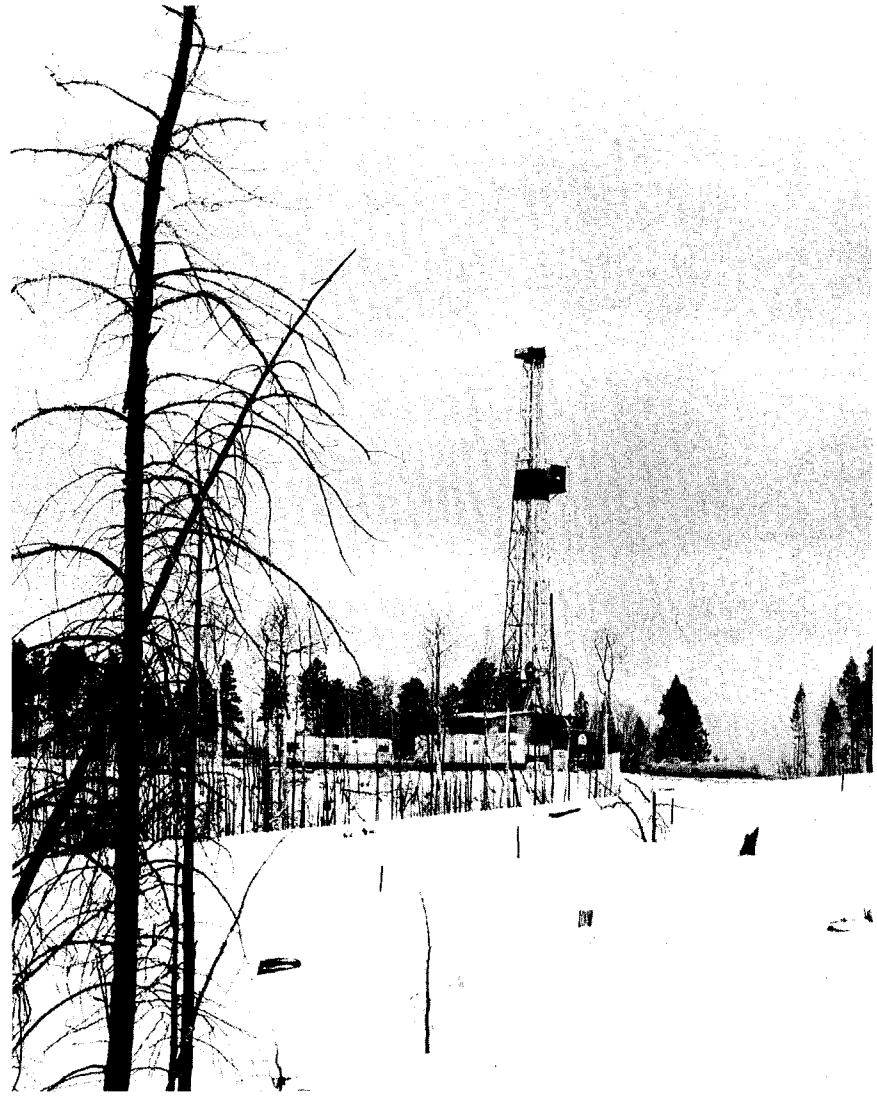
Better means of knowing just what is going on deep underground are being devised. At the surface, seismic recorders, no matter how sensitive, do not record much of the very weak signal generated by fracturing. But Q-22 may find that seismographs deep in the hole, combined with those on the surface, will provide more adequate measurements. Different rock has different electrical resistivity, which also changes with pressure. In cooperation with the University of New Mexico, Q-22 is experimenting with instruments to pass current through thousands of feet of rock; variations while fracturing may yield useful data.

Where to Now?

As *The Atom* goes to press, unusually severe winter weather has stalled fracturing, but by the time you read this, Q-22 may have accomplished it. Assuming success, Q-22 may then attempt to develop a circulatory system within the hole. Extensive testing would be conducted this spring and summer.

Later this year, another pair of holes would be drilled nearby. In 1977, an experimental facility would be built at the wellheads—the world's first dry geothermal energy extraction system.

In the meantime, results to date have been sufficiently encouraging for geologists, physicists, engineers, and others with a stake in geothermal energy to plan a national meeting this spring to consider ways to survey and tap dry geothermal resources throughout the country. In the East, an area of less recent volcanic activity, deeper, more expensive drilling may be necessary to reach adequate temperatures. Or, more logically, technology may be developed to use lower-temperature heat, such as the use of isobutane or Freon that operate on lower-temperature liquid-vapor cycles.



The drilling rig has departed, but the snow that has slowed fracturing experiments remains at LASL's Fenton Hill geothermal site. Hydraulic pressure will be used to fracture rock in an attempt to produce a circulatory loop in hot, dry rock.

But in the West, an area of much more recent volcanic activity, LASL's methods, now under development at Fenton Hill, may show the way for future commercial geothermal power plants.

LASL geothermal scientists estimate that just a cubic mile of rock in the vicinity of the bottom of the present Fenton Hill well contains enough heat to supply all of the United States' energy needs for a week. Potential like this exists, LASL scientists believe, in many other regions of the country. Realizing even a fraction of this potential could make a substantial contribution to America's energy resources.

And that is why putting on the pressure at Fenton Hill this month is a turning point that will be watched with more than passing interest by geothermal researchers around the nation.

short subjects

Honors: The late **Wright Langham,** formerly associate H-Division leader, has been honored by having 2 books dedicated to his memory: **Space Radiation Biology and Related Topics,** published by the Academic Press, and **Uranium—Plutonium—Transplutonic Elements** published by Springer-Verlag. Langham was an authority on the biomedical aspects of the actinide elements. He lost his life with 7 other LASL employees in an air accident in Albuquerque on May 19, 1972.

On January 15, the Laboratory was 1 of 7 organizations receiving special citations during ceremonies at Germantown, Maryland, for outstanding contributions to the nation's uranium enrichment and national security programs.

From ERDA: **John Erlewine,** general manager of the Atomic Energy Commission since February 1974 and with the AEC since 1952 has retired. Because the Energy Research and Development Administration, successor to the AEC, has no equivalent post, no replacement will be named.

Three electron-beam pulsers, each capable of generating a 300-kilovolt pulse with a peak power of over 2 billion watts, are being built for delivery later this year to the new CO_2 laser facility under construction at Ten Site. The present CO_2 laser system generates several hundred joules in a single beam. A new system under construction will produce 2½ kilojoules in 2 beams this summer. The CO_2 laser system to be installed in the new laser fusion laboratory will generate 10 kilojoules in an 8-beam array. This will be a factor of 4 increase in energy in order to do laser fusion research.

The Laboratory is now accepting applications for the September, 1975, class of its Machinist Apprenticeship Program. Application should be made at the LASL Personnel Department by 5 p.m., February 28. Desirable qualifications include high-school-level algebra and trigonometry. The Shop Department has 27 apprentices currently enrolled and 45 of the Department's machinists are graduates of the program.

Is there something wrong with the sun, the theory of solar neutrinos, or the measurement methods? **Raymond Davis** and **John Evans,** Brookhaven National Laboratory physicists, are puzzled that after several years their tanks of carbon perchlorethylene deep in a South Dakota gold mine have detected virtually none of the massless, chargeless particles presumably emanating from the sun and streaming through the earth.

Checking the measurement methods is the first step in finding what's wrong. With the assistance of **Stewart Meyer,** Northwestern University and the National Science Foundation, a tank containing carbon perchlorethylene and another containing calcium nitrate have been installed at the beam stop of the LAMPF accelerator. While LAMPF is inoperative for maintenance and upgrading until July 1, the tanks will be used to measure neutron and cosmic ray backgrounds. When the beam becomes operative, its known neutrino production will enable the investigators to measure extremely small neutrino cross sections and check the neutrino + chlorine-37 → argon-37 + electron reaction upon which the detection system is based.

Why solar neutrinos have not been detected in anywhere near the quantities that theory predicts is a question of deepest concern in astrophysics today. Hopefully, LASL's cooperation will lead to some answers.

Retrieving information on nuclear and energy-related subjects has been speeded up due to a RECON station recently installed at the Main Library. The station—along with 32 others like it around the country—connects to an IBM 360/75 computer at the Holifield National Laboratory at Oak Ridge, Tenn. Researchers can obtain information from hundreds of thousands of biographic references by viewing them on a cathode-ray tube display or on printouts.

Retirements: **Robert O. Whitson,** SP-DO, assistant department head; **Gilbert P. Apprill,** E-1, instrument technician supervisor; **Hugh J. Gay,** SD-5, laboratory machinist; **John L. Lundgren,** CMB-11, staff member; **Horace Noyes,** SP-DO, traffic manager; **Thelma F. Northrup,** AO-2, senior accounting clerk.

Deaths: **Clarence F. Lopez,** J-7, draftsman; **Charles Cremer,** TD-2, group leader; **Xavier Lovato,** CTR-4, electronics technician; **Robert G. Martinez,** CMB-14, decontaminator.

LASL's Minicomputer Ambassadors

Do you have laboratory equipment that could be better controlled or data collected and analyzed from it by a minicomputer?

If so, maybe you should call for one of LASL's minicomputer ambassadors.

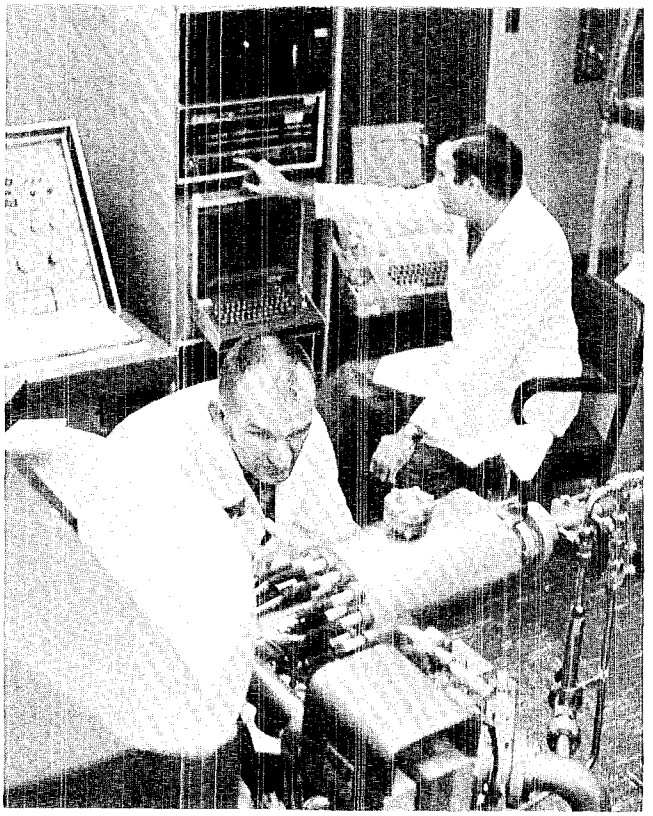
These men of Group E-5 (minicomputer systems) have know-how, will travel. Their specialty is meshing a comprehension of your needs with their expertise in contemporary minicomputer hardware and software. Some virtually "live" with the Laboratory groups to whose projects they've been assigned for extended periods of time.

And they'll service what they sell. Group E-5 has a maintenance section to keep their systems—all more or less custom-tailored to specific needs—"go". There's no limit on their warranties.

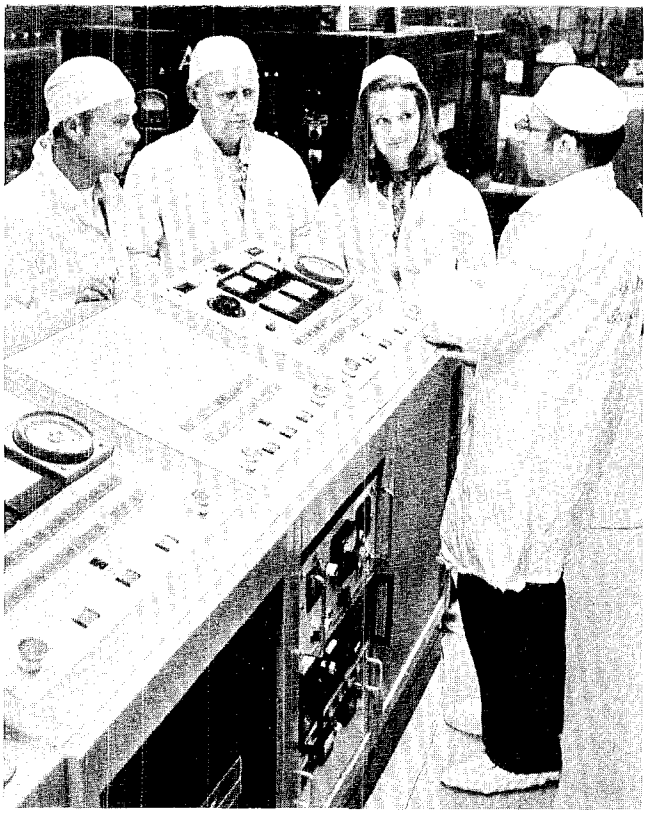
Group E-5 was formed only last summer, but now numbers 31 people, many of whom are senior specialists with 10 or more years of minicomputer experience. "For this kind of work where our people face completely new requirements from one job to the next, we place a premium on experience," Dale Van Buren, E-5 group leader, explains. And he adds that an important by-product of this policy is that it fosters continuing professional development. "After acquiring extensive experience, a minicomputer expert often feels a bit restricted if he can apply but a portion of his know-how in a specialized job. Our people like the variety of challenges that come their way," Van Buren adds.

Minicomputer-system engineering is predicated heavily upon the modular concept, each module in a system being a rectangular box, perhaps 4 inches thick and 1 to 2 feet in length and breadth. Modules fit into standard racks; various modules in differing arrangements with appropriate interfaces and controllers can be assembled for almost infinite applications.

And Group E-5 is already deeply involved in the next generation of computers: microcomputers, a substantial step down in size. Group E-5 has designed prototype modules which are now being built and tested. A functional microcomputer can be assembled on a card merely 4 by 6 inches, yet has approximately the same capability as the discon-



Bob Abernathey, CMB-1, and Jay Wooten, E-5, calibrate a minicomputer-controlled AVCO mass spectrometer for characterizing radioactive material.



Van Buren, Dwight Stephenson, and Katie Greiner, all E-5, and Steve Hodson, CMB-11, discuss industrial controller system for the 501 plutonium handling line at DP West.

tinued PDP-9 minicomputer of a dozen years ago which measured approximately 6 feet by 2½ feet by 2½ feet.

The dividing line between mini and micro is not a sharp one, however, but a "gray" area. E-5 system designers do not hesitate to integrate micro components into mini systems, such as a micro CPU (Central Processing Unit) for "smart" or decision-making, capability in a mini system.

Differences in capability, size, and cost are not necessarily determinants of what is mini or micro. From a technological viewpoint, a basic difference is the memory unit used, a difference that made a microcomputer system ideal for an unusual application at the Nevada Test Site.

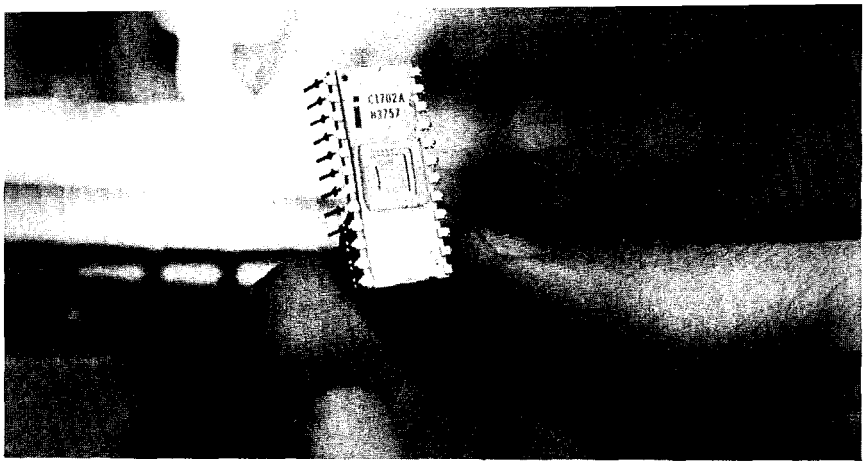
Micros Vs. the Shock Wave

As Dwight Stephenson, E-5 senior designer consultant, explains it, "Minicomputers, much more so than micros, rely on core memories. Core memories are fine for most applications, but when extraneous signals are introduced, or transient electrical disturbances occur, the program in a core memory can be erased.

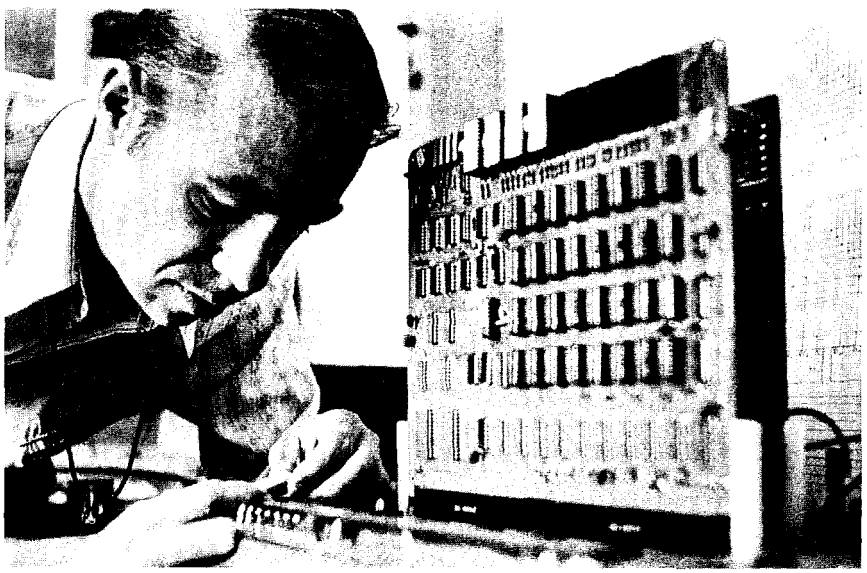
"Not so with the Programmable Read-Only Memory (PROM) we use to store programs for microcomputers. Electricity or magnetism can't erase them. Only ultraviolet radiation can do that—it takes a substantial dose. If you left a PROM in sunlight it would take 5 to 10 years to wipe out its memory.

"When we were asked to design an improved transient data recording system for use in a skid shack near ground zero during underground tests at the Nevada Test Site, we naturally thought of microcomputers. Before the test, extraneous signals can be generated as downhole instrumentation is connected and tested. And after the shot, the shock wave and electromagnetic pulse can disrupt or cut off power, downhole lines can be shorted, and all sorts of electrical disturbances can occur. The PROM gives us insurance that the program won't be lost when these things happen."

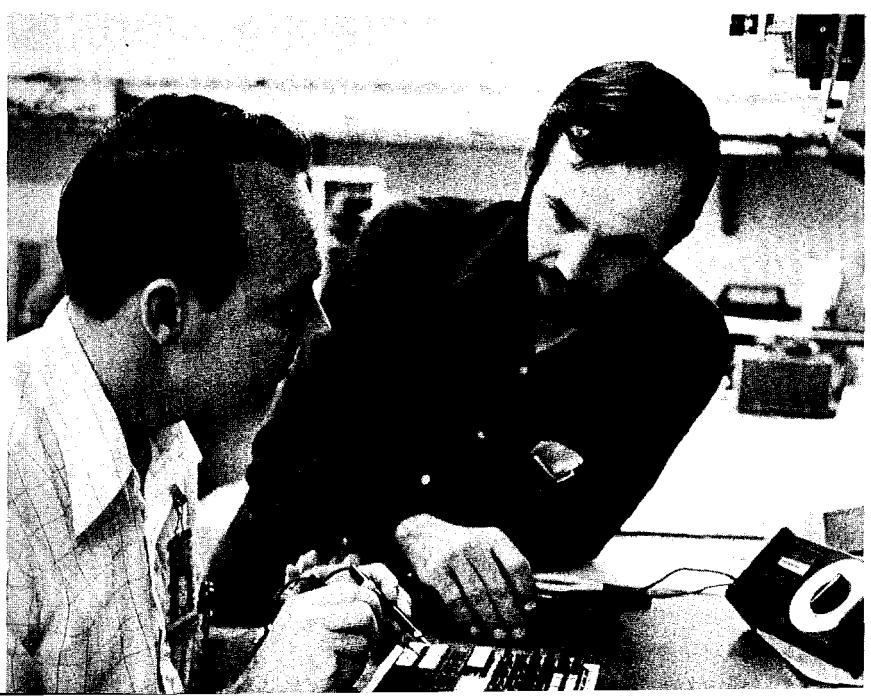
During a test, the system scans various data-collection stations, records, transmits, and stores data as it is received during the shot, and shuts itself off just prior to the



A PROM is not only compact, but extremely durable. The program stored in the memory unit is unaffected by magnetic and electrical influences, can be erased only by intense ultraviolet radiation.



Dale Van Buren, E-5 group leader, inserts a PROM (Programmable Read-Only Memory) into a console programmer. Below, Jerry Longmire, E-2, tests a prototype microprocessor being developed by E-5 for the group's electronic stock as designer Al Criscuolo, E-5, watches.



arrival of the shock wave about 7/10 of a second later.

The new microcomputer system also speeds up data analysis by eliminating the previous procedure of photographing visual computer displays at the shot site. Now data is processed at Central Control and can be viewed immediately after a shot, either as a visual display or as a printout.

In future systems now being designed to transmit more data, even greater reliance may be placed on stored rather than transmitted data. "The limiting factor is not the microcomputer, but the ability of microwave systems to carry data," Stephenson says.

Suspicious Twins

At LASL's new $70 million plutonium facility now under construction, Group E-5 is working out the details of one of the world's more sophisticated remote multiplex systems. Unlike the NTS system, the installation in the plutonium facility relies on minicomputers rather than microcomputers.

"In many respects, micros are the wave of the future," Stephenson explains. "Yet, minis still have greater capacity, and that's what we wanted for the new plutonium facility. There we don't face the severe conditions present at the NTS. And we use a photo-isolator, or light transmittal system, from the plant sensors to the minicomputer's core memory, to assure that electrical influences can never erase the programs."

Among major design requirements was the use of a minimum amount of copper wire. As it is, the new building will incorporate approximately 25 miles of it for its remote multiplex system. Without employing the multiplex concept, and with a pair of lines connecting some 2,600 points to the central control unit, that amount would have been about 200 miles, or an additional $65,000 for copper wire and its installation.

A multiplex system utilizes field multiplexers, or substations, to

gather information from a number of points in their vicinities. Each multiplexer then transmits data to the central control unit over a single pair of wires, accounting for substantial savings.

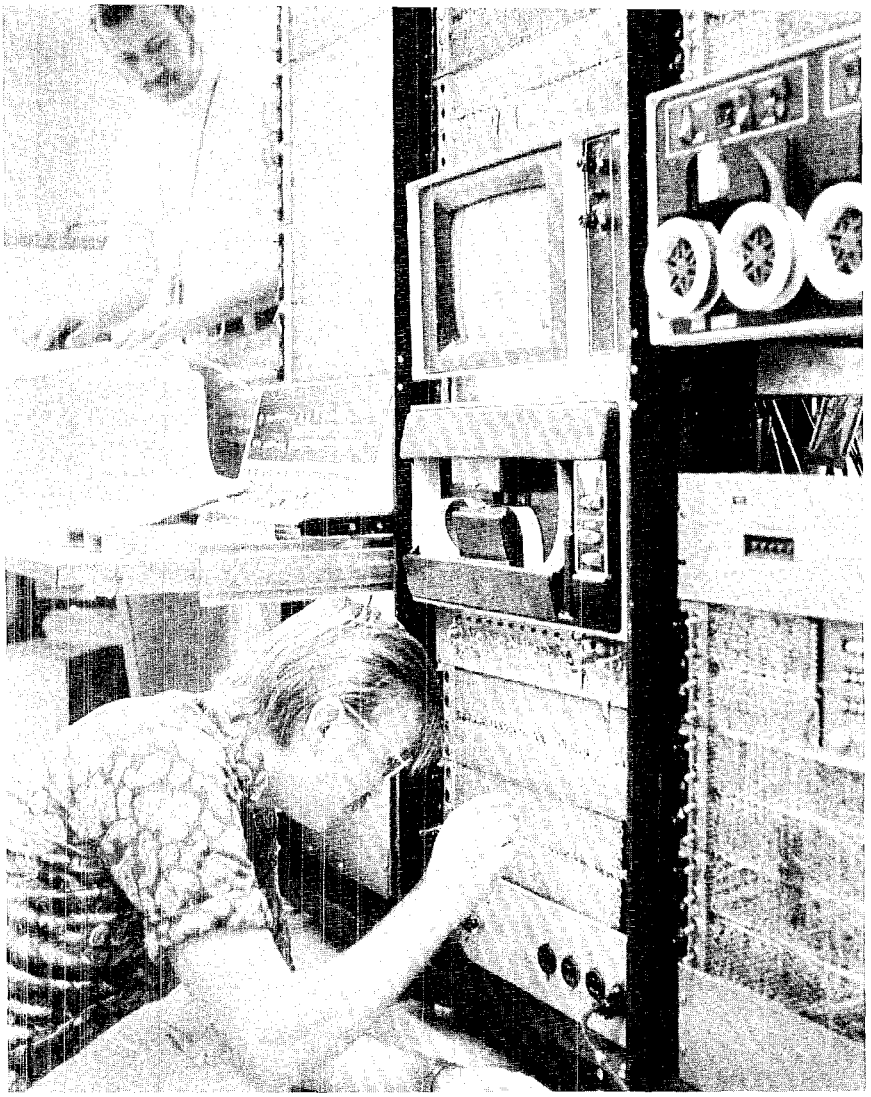
The system is replete with fail-safes, most noteworthy being 2 minicomputers which cross-examine each other several times every second. These suspicious identical twins alternate in analyzing and reporting data. While one computer is doing its job, the other is monitoring it to see that it is doing it correctly. Then, the twins switch roles. If one computer should fail, the other shuts it off and takes over completely.

The remote multiplex system monitors the massive building's fire-alarm, air-conditioning and heating, and radiation-detection systems. As is customary in computer system engineering, a reserve capability is built in to accommodate possible future needs. This reserve capability can be utilized for such tasks as experimental process control and reducing overall energy consumption. For instance, E-5 anticipates that the current 100-kilowatt-power consumption of electrodryers currently used may be reduced 67 per cent or more.

All Around the Laboratory

Other Group E-5 projects include a minicomputer system being developed by Bill Barnett for Group L-1's CO_2 laser; a computer data acquisition and control system being developed by Paul Johnson for Group M-2's Phermex Enhancement Program; a computer-based sample radiation counting system being developed by Tom Kuckertz for Group H-1; and a computer-based time sharing terminal and plotting system being developed by Andy Kozubal for Group WX-1.

For a group so young, E-5 has become extensively involved with other groups throughout the Laboratory. All in all, E-5 has 15 projects "on the books" at various stages of consultation, design and engineering, and installation.



Ron Rosul, E-5, changes wires on a PDP-15 computer system as Fred Gilliland, E-5, calls out wire locations. Having an in-house maintenance capability saves LASL an estimated 40 per cent in service costs.

Keeping Systems "Go"

Because maintenance of sophisticated minicomputer systems can best be accomplished by those close to the systems from the outset, and because maintenance is inseparable from parts and inventory control, E-5 has set up its own 9-person maintenance section headed by Fred Gilliland.

"Our parts and inventory situation could really get out of hand," says Gilliland. "Sure, we require a great many different parts and components to give us the versatility we need in putting systems together and servicing them afterwards. But we need to standardize, if we can, on a few 'families' of equipment to keep our parts list from mounting sky high. We really haven't got the answer yet, but we're working on it."

By performing maintenance in house rather than relying upon vendors—except for that type of service covered under manufacturers' warranties—Gilliland estimates that the Laboratory saves about 40 per cent on service costs.

Among the benefits of in-house maintenance is a management information system to feed back data on parts performance and problems to the manufacturers to assist them in product improvement and new product development.

As an example, Gilliland and his

section deal with at least one exotic problem that arises in Los Alamos, but in few other places: altitude. "Because of our altitude, high-voltage arc-overs forming coronas will occur between some exposed terminals that won't occur at lower altitudes. We have to check this out when we buy certain parts. If manufacturers take this factor into consideration at the design stage, it would be helpful for both of us."

New Emphasis on Software

A universal trend in computer systems design—maxi, mini, or micro—is for equipment costs to decline while the cost of software, that is, of writing programs in appropriate languages, increases. In 1965, approximately 80 per cent of a computer system's cost was for hardware, 20 per cent for software. Today, the ratio is reversed, reflecting both a radical decline in equipment costs, especially for the minis and micros, and a rapidly proliferating variety of intricate programs to take full advantage of the hardware's increasing sophistication and versatility.

To cope with software costs, an 8-person section of Group E-5 is creating a program library, standardizing programs with a wide range of potential applications, and utilizing higher level languages. Software development has reached the stage where the minicomputer experts are turning to minicomputers themselves to assist in program writing.

Yet there remains one realm that does not appear amenable to minicomputer usage: cost estimating. "We just do like everyone else—sit down and estimate the man-hours involved, total an amount for hardware, do a little intelligent guessing about the uncertainties we're likely to encounter, and come up with a figure that's in the ballpark," Van Buren admits.

It appears that until a new development in mini- or microcomputers comes along, at least for some chores, the oldest computer of all will have to suffice: the human brain.

10 years ago in los alamos

Culled from the January and February, 1964, files of The Atom and the Los Alamos Monitor by Robert Y. Porton

LASL Bit Melts Through Earth

A LASL-developed drilling bit, which melts its way through solid rock, may be the answer for making holes in the earth to depths impossible by conventional drilling methods. The bit is the outgrowth of an academic discussion by members of Group CMF-4 about geophysics. In experiments here, a 2-inch diameter bit, heated electrically to 1,200 degrees Celsius, drilled through basalt at the rate of 50 feet per day.

New Homes

A year-end tally by the AEC of privately-owned houses constructed in Los Alamos County to date under AEC land-sale programs, shows that 259 residences have been completed by individual owners on Barranca Mesa. Some 195 homes have been built at White Rock and Pajarito Acres.

LASL Accelerators Set Record

LASL physicists have achieved the highest particle energies ever obtained with electrostatic accelerators by hooking two Van de Graaff machines together in a series. The new record of 25.4 MeV (million electron volts) was reached after only several days of testing with the older vertical unit in series with the recently installed Tandem Van de Graaff.

State's Lawmakers Visit Los Alamos

New Mexico's lawmakers—85 members of the State Legislature—visited Los Alamos this week. For many members of the group it was their first look at the Atomic City. The visit was hosted by the Laboratory, the AEC, Los Alamos County and the Chamber of Commerce.

Supermarket Ad

This week's specials at a local food store include: Sugar—10 lbs. 99c; Chuck Roast—45c lb.; Hams—49c lb.; Ice Cream—49c ½ gal.; Coffee—63c lb.

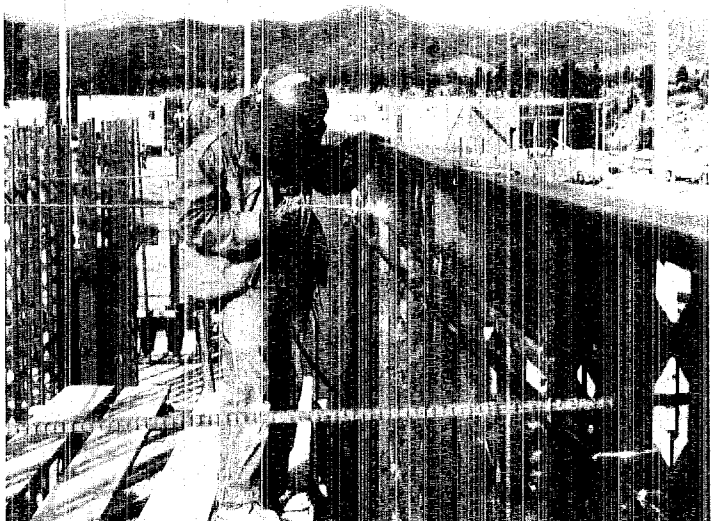
AEC Award

George Cowan, J-11 group leader, was named a 1965 winner of the E. O. Lawrence Memorial Award. The award by the Atomic Energy Commission is made annually to selected scientists for "meritorious contributions in the field of atomic energy." Theodore Taylor, a former LASL staff member, is another recipient of this year's award.

Protective Force Inspectors are not normally this demonstrative while in uniform, but an exception is Loretta and Margarito Martinez. Loretta Martinez is the Pro Force's first woman inspector to be assigned to active duty in the field, and the two are the first married couple to serve together on the same security force at LASL, if not the nation. The Pro Force has 3 other women inspectors qualified for field assignment.

This photomicrograph (the original is in color) is a double winner for Julie Grilly, H-DO. After winning 3rd place for "color on the job" at the Industrial Photographers of the Southwest competition last summer, it was sent to New York City where it won honorable mention at the 44th Annual Meeting of the Biological Photographic Association. Magnification of a crystallized organic compound, using polarized light, was 720 times.

The Laboratory's construction boom continues. At left, L-Division's new $4.7 million laser fusion laboratory at Ten Site proceeds not just on, but ahead of schedule as work is now 28 per cent complete compared to the 21.7 per cent planned as of mid-January. Structural completion is targeted for October. Structural work of the new $70 million plutonium processing facility at TA-55, right, is well along with completion scheduled for early July.



Pretty Starr Caswell, a 9th grade Pueblo Junior High School student, models for ISD-1 photographer, Bill Jack Rodgers.

Whoops!

Gallantly, Starr brushes herself off and continues with poise.

Rodgers' assignment was to take a picture that would remind Los Alamos residents of their abundant winter recreational opportunities at the Pajarito Mountain ski area and the community ice skating rink in Los Alamos Canyon. Unfortunately, the ice skating rink is shaded by the canyon walls; the sparkling sunlight Rodgers sought was at Ashley Pond. Since ice skating is not allowed at Ashley Pond, Rodgers had to both obtain special permission and clear snow off a patch of ice. Events proved that Rodgers is a better photographer than shoveller; the snow he left behind was enough to trip Starr in her demonstrations.

Nevertheless, it's results that count and the point is made. Enjoy one of Los Alamos' finest seasons of winter sports while you may.